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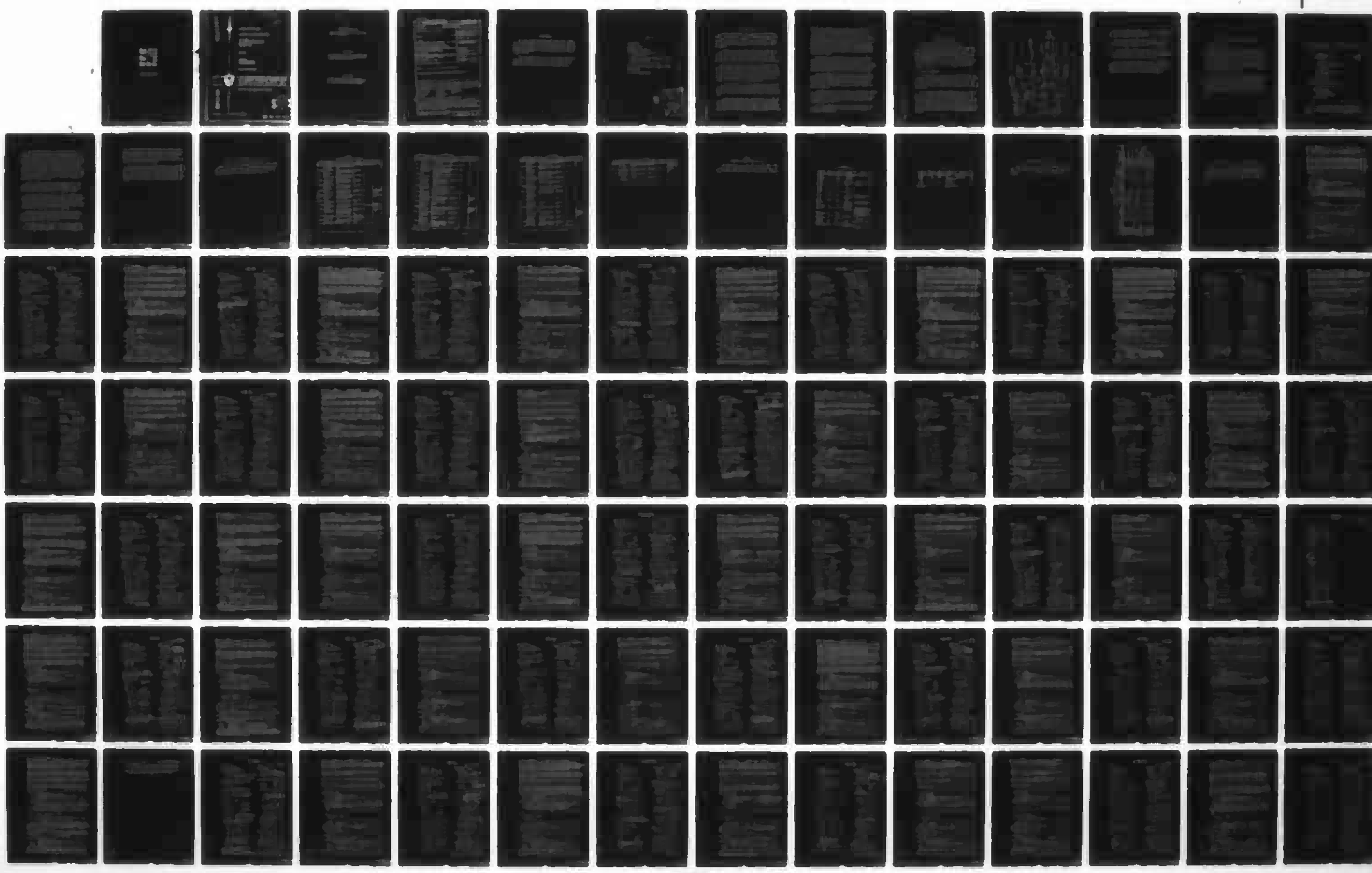

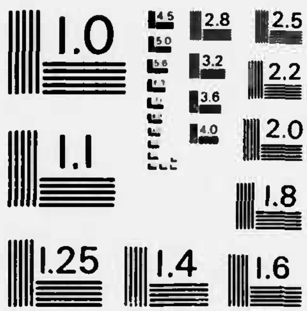

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TECHNICAL REPORT RH-CR-83-6

A SURVEY OF ELECTRIC LASER CODES

Francis C. Wang
Lockheed Missiles and Space Company, Inc.
Huntsville Research and Engineering Center
4800 Bradford Drive
Huntsville, AL 35807

JUNE 1983

Prepared for
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US Army Missile Laboratory

Contract DAAH01-80-C-1289

U.S. ARMY MISSILE COMMAND
Redstone Arsenal, Alabama 35898

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The publication date is different from the performance period for this work. This delay in publication was caused by the Army's desire to include this work in a large report which contained all laser code surveys. However, such a task was not completed.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Electric Lasers	CO_2 Lasers	Gas Dynamics
Computer Models	CO Lasers	Optics
Pulsed Lasers	Excimer Lasers	
CW Lasers	Kinetics	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report summarizes information gathered on a survey conducted by the Lockheed-Huntsville Research & Engineering Center under Tasks I and II, Contract DAAH01-80-C-1289, on available computer codes which can be used to analyze electric laser devices. The laser systems include CO, CO_2, and excimers. operating in either the CW or pulsed modes. Technical areas surveyed include kinetics, optics, and gas dynamics.

FOREWORD

This report summarizes information gathered on a survey conducted by the Lockheed-Huntsville Research & Engineering Center under Tasks I and II, Contract DAAH01-80-C-1289, for the U.S. Army Missile Command, Redstone Arsenal, Alabama. This work was monitored by T. A. Barr, Jr. The period of performance covered by this report was from 1 July 1980 to 30 November 1980.

The author acknowledges many valuable conversations, assistance and encouragement provided by T. A. Barr, Jr., and J. Thoenes, as well as many others throughout this work. The author is also grateful to T. G. Roberts for his efforts in making publication of this report possible.

CONTENTS

1. INTRODUCTION

Computer modeling has contributed greatly toward development of advanced technologies such as lasers and is expected to play an even more important role in the future. This is true as the computer models become more realistic, computation costs decrease, and as the number of design parameters increases, making optimization by laboratory search almost impossible.

Through the years, many computer codes have been developed for the analysis of laser systems and their components. Most of these codes are in the public domain, and individuals who wish to obtain copies of these codes can usually do so. However, due to the large number of codes available, selection of a proper code to fit the individual's need may be a difficult task.

Each computer code has been developed with its own purpose and its inherent limitations. Depending on the phenomena included, and the details of treatment of these phenomena, applicability of different codes vary. There are simple codes for laboratory data analysis. There are detailed engineering design codes. There are also systems codes which provide an end-to-end analysis. An understanding of the capabilities and limitations inherent in each computer code is thus important to the prospective user.

Besides the analytical treatment of the various phenomena involved in the code, the prospective user will require certain general information on how to use the code. The computer language used, the core memory requirement and the computer run time all influence the suitability of using a specific code.

To alleviate this difficulty, laser computer codes were surveyed. As part of the Army High Energy Laser 6.1 effort, a survey of laser propagation codes was performed in 1979 by J. P. Reilly of W. J. Schafer Associates, Inc. This survey was published by D. W. Howgate, C. M. Bowden, and T. G. Roberts (editors), in "New Laser Concepts Evaluation—Review," MIRADCOM

Technical Report DRCPM-HEL-79-4, Redstone Arsenal, Alabama, in February 1979. Unfortunately, the distribution of this report was limited to Government agencies only. An excellent survey of Continuous Wave Chemical Laser codes was performed by C. Wiggins, D. Mansell, P. Ulrich, and J. Walsh, and was published as "Chemical Laser Code Survey," BDM/TAC-79-769-TR-R1, BDM Corporation, Albuquerque, New Mexico, July 1980. More recently, two additional surveys were performed for electric laser codes and for pulsed chemical laser codes. The survey of electric laser codes reported herein, and the pulsed chemical laser code survey performed by Melvin Epstein and Robert R. Giedt of the Aerospace Corporation, were part of the Army High Energy Laser 6.1 effort.

In this study, we surveyed the industry for available codes which can contribute to the analysis of electric laser devices. The laser systems treated include CO, CO_2 and excimers, operating in either the CW or pulsed modes. The initiation may be self-sustained, E-beam initiated or UV-initiated. The flow system may either be open system, closed system or closed cycle. Technical areas surveyed thus include kinetics, optics, and gas dynamics.

Section 2 presents a general description of a high power electric laser system and its key components. The technical areas covered in this survey are then delineated. Section 3 presents a summary of the survey and its results. A general classification of the codes surveyed is also attempted. Section 4 presents the detailed return of all surveyed codes. Section 5 containes the references.

Participation in these surveys was voluntary, and therefore some existing codes may not be included. Also, as was pointed out by A. Garscadden in a private communication, references to the data banks and overview publications are not included. The reader may find many interesting references in the Selected Bibliography, Page 113.

This survey complements other previous code surveys covering areas of laser beam propagation (Ref. 1), chemical laser devices (Ref. 2), and pulsed chemical lasers (Ref. 3).

2. PREPARING THE SURVEY

2.1 COMPONENTS OF AN ELECTRIC LASER SYSTEM

A high power electric laser system can be delineated into different components as shown schematically in Fig. 1. The portion included in this survey is enclosed in the box entitled "Laser Device." It contains such components as gas supply and preparation subsystem, injector and mixing subsystem, cavity resonator, exhaust treatment and recirculation system, acoustic attenuation subsystem and electric power supply subsystem. Computer codes which can be used to provide analysis for processes and phenomena occurring in one or all of the above mentioned components are subjects of this survey.

2.2 AREAS OF COVERAGE

A set of questionnaires was prepared to cover the technical areas of interest as well as information related to computer usage. A format similar to that used in Ref. 2 was adapted for use in this survey. Survey questions were grouped under the four headings of General Information; Optics; Kinetics; and Gasdynamics. Many of the questions used in the BDM survey are retained in this study.

Under the heading of GENERAL INFORMATION, questions are asked that relate to the purpose, unique capability, and limitations of the code. Questions are asked that relate to the availability of the code and its supporting documentation, as well as its computer compatibility. A key contact at the code residing organization is defined who may or may not be the originator of the code. No special effort was expended to identify the originators on all the codes surveyed, although in many cases it was necessary to communicate with the originators in order to obtain technical details about the code.

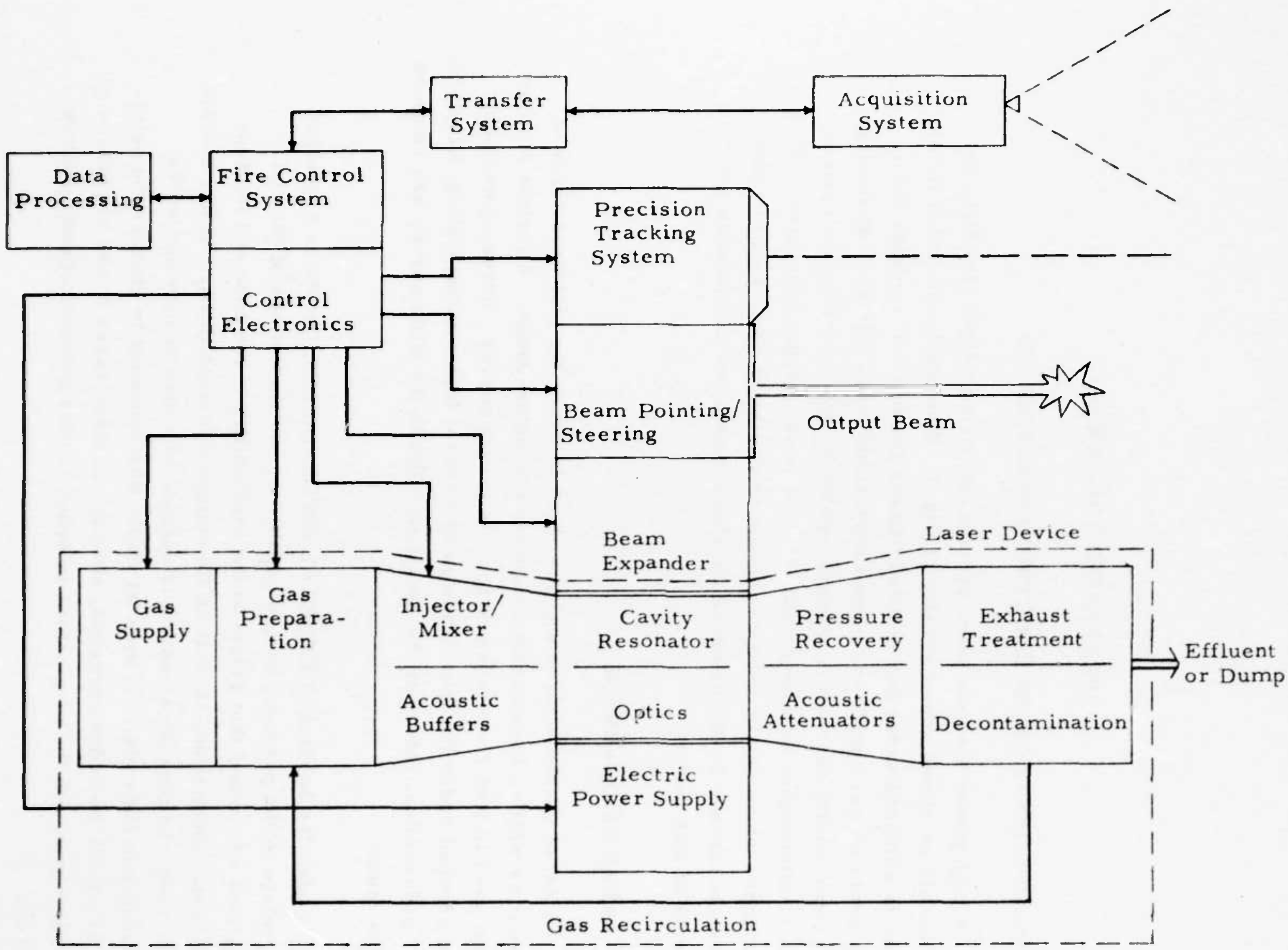

Fig. 1 - High Power Electric Laser System Components

Following the GENERAL INFORMATION section are questions grouped according to the technical areas covered by the code. Thus, a code return may contain any or all of the questions under Optics, Kinetics and Gasdynamics.

The questions under the heading of OPTICS deal primarily with the treatment of wave propagation within the laser resonator. Questions used in Ref. 2 were retained if they applied to the electric laser configurations.

The questions under the heading of KINETICS deal primarily with the treatment of plasma dynamics, lasing kinetics, and power extraction processes. Boltzmann codes used for electron energy distribution calculation and energy deposition codes for E-Beam systems are also included.

Questions under the heating of GASDYNAMICS deal primarily with the treatment of gas flow through the system and its interaction with the various components. The treatment of viscous mixing in the cavity, the acoustic propagation and its attenuation for a pulsed system, and pressure drops through the recirculation system are all included in this category.

3. A SUMMARY OF ELECTRIC LASER CODE SURVEY

3.1 INFORMATION GATHERING

A list of survey recipients was compiled from information obtained from several sources including the Army Missile Command, Naval Research Laboratory, Air Force Weapons Laboratory, and Air Force Wright Aeronautical Laboratories. This initial list of recipients was supplemented with additional names and organizations as the survey progressed, making a total of 55 organizations identified as survey recipients. These organizations include government laboratories, academic institutions, and private industries throughout the country. After having identified one or two individuals at each organization as the contact point for the survey, questionnaires were sent to all the identified organizations.

Phone conversations and personal visits to some survey recipients followed the initial mailing in order to speed up the survey return, to discuss fine points on the survey, and to clarify questions on the returned questionnaires. In spite of all these followup activities, returns of the survey were slow. After much effort, 42 returned questionnaires were obtained. These returns, after being reviewed and retyped, are presented in Section 4. A summary of the survey results is given in the following subsection, in which an attempt is made to classify these codes.

3.2 A CLASSIFICATION OF SURVEYED CODES

Forty-two of the electric laser related codes that were surveyed are generally classified as follows:

Classification of Codes		No. of Codes
LASER KINETICS		21
General excimer laser code	5	
Specific excimer laser code	3	
CO_2 laser code coupled to physical optics	2	
CO_2 laser code	7	
General vibrational-rotational laser code	1	
CO laser code	3	
PLASMA KINETICS CODE		6
ELECTRON KINETICS CODE		6
PULSE FORMING NETWORK CODE		1
LASER GASDYNAMICS		7
Cavity gasdynamics	4	
Closed cycle gasdynamics	3	
GENERAL OPTICS		1
Total		42

A brief summary of all the codes surveyed is given in Table 1. Detailed returns of all codes are given alphabetically in Section 4. In the succeeding paragraphs, summaries for the different classes of codes are given.

The laser kinetics codes calculate the upper and lower state populations for the given lasing transition under the operating condition. The code may either be programmed to accept only a specific lasing transition or it may be more general in order to accept different reaction mechanisms from input data. Depending on its complexities, the code may contain mechanisms for the calculation of plasma kinetics, energy deposition, power extraction and gasdynamics. Most codes treat at least the Fabry-Perot resonator, a few (TDFI-EDL and UNSEDL2) have coupled physical optics which can treat other types of resonators as well. The laser kinetics codes are summarized in Table 2, where the applicable gas systems, the type of operation, and initiation method included in each code are listed. Also listed are comments related to specific features of the code.

The plasma kinetics codes deal with energy deposition into the cavity gas for either an E-beam discharge (E-BEAM TRANSPORT, EBAM2, and EBM2D) or discharge only (DENSITY, HGX80 and KINBOLTZ). Some may also be coupled to the pulse forming electric circuits (e.g., EBEAM2).

The electron kinetics codes are used to calculate the electron energy distribution function by solving the Boltzmann equation. Transport properties are then obtained from the distribution function. These codes are usually linked to the plasma kinetics codes or the lasing kinetics codes, thus forming a coupled code. Because of the different types of collision processes treated, the usage of these codes is thus considered case dependent.

The pulse forming network (PFN) codes provide electric current for the discharge pulse. Since the gas properties in the laser cavity affect the outside current, the analysis of PFN is usually coupled with the plasma kinetics codes for energy deposition calculation.

The gasdynamics codes are classified as either a cavity gasdynamics code or a closed cycle system gasdynamics. The cavity gasdynamics code treats the cavity gas medium homogeneity as the result of flow mixing in the cavity, the acoustic wave generation due to the pulsed operation or non-uniform energy deposition. The system gasdynamics codes deal specifically with thermodynamics of closed gas systems. It provides transient analysis as well as steady state solution for the flow loop. The gas-dynamics codes are summarized in Table 3 where the flow equations used and the special features treated are listed.

Of all the codes surveyed, only two have physical optics coupled with the lasing kinetics. This might be the result that many an analysis has been done with separate kinetics and optics codes. Extensive survey of optics codes as applied to resonator analysis and design has been conducted by BDM (Ref. 2) for chemical lasers. No duplication is intended in this study. A general optical system optimization code (ILLOPT) is included in this report.

Table 1

SUMMARY OF ELECTRIC LASER CODE SURVEY

This table summarizes the 42 codes surveyed. Listed under each code is information pertaining to: the residing organization; the key contact; the principal purpose of the code; available documentation; and comments. Detailed returns of all codes are given alphabetically in Section 4.

Table 1

SUMMARY OF ELECTRIC LASER CODE SURVEY

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
BACPR	Joint Inst. for Laboratory Astrophysics A. V. Phelps (303) 492-7850	To predict electron transport, excitation, and ionization coefficients from cross-section data	Electron Kinetics	T, U, L, RP	
BMLASE	Westinghouse R&D Center Lyle Taylor (412) 327-5833	To model the laser kinetics of a pulsed 14 μm and 16 μm CO_2 laser, and to predict its performance	Laser Kinetics (CO_2)	T	P
BOLTZ	AFWAL CPT Gary L. Duke (513) 255-2923	To predict electron transport properties, excitation pumping rates from given E/N and cross-section data	Electron Kinetics	U	
CCUBE	U. of Alabama in Huntsville Gerald R. Karr (205) 895-6330	To compute flow properties throughout a closed circulator for a steady state CW laser	System Gas Dynamics	RP	
COLASE	Westinghouse R&D Center Lyle Taylor (412) 256-5833	To model the laser kinetics of a pulsed, electric discharge CO laser, and to predict its performance	Laser Kinetics (CO)	T, U	
DENSITY	AFWAL CPT Gary L. Duke (513) 255-2923	To determine the time dependent species concentration voltage, and current in an XeCl laser plasma	Plasma Kinetics (XeCl)	None	Time-Depend. Discharge Model
E-Beam Transport	R&D Associates T. K. Tio (213) 822-1715 X 448	To model the E-Beam transport in the 2-D discharge gap of an EDL under prescribed E-field and B-field	Plasma Kinetics	T, U, L	2-D E-Beam Model
EBEAM	MICOM Arthur Werkheiser (205) 876-8161	To compute time history of CO_2 electric laser power output for E-Beam lasers	Laser Kinetics (CO_2)	L, U	
EBEAM2	MICOM Arthur Werkheiser (205) 876-8161	To compute time history of E-Beam gun and sustainer voltage and current from a given power supply	Plasma Kinetics	In Preparation	Time-Depend. E-Beam Model
EBM2D	MICOM Arthur Werkheiser (205) 876-8161	To compute 2-D distribution of electron density, E-field, and power deposited in an electric laser cavity for a given potential difference and current	Plasma Kinetics (CO_2)	T	2-D E-Beam Model
EDLAMP	Lockheed-Huntsville Jürgen Thoenes (205) 837-1800	To predict cavity performance of an E-Beam controlled EDL	Laser Kinetics (CO_2) Coupled with Gasdynamics	T, U	
EDLNOD	AFWL CPT Robert F. Walter (505) 844-1786	To predict small signal gain and energy extraction for CO_2 EDLs	Laser Kinetics (CO_2)	L, RP	

*T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

(Continued)

Table 1 (Continued)

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
EDLSL	AFWL A. T. Gavrielides (505) 844-4691	To model the kinetics of photon production by a glow discharge in an EDL cavity	Laser Kinetics (CO_2)	None	
EED	Tetra Corp. Henry J. Happ, III (505) 256-3595	To solve the steady state electron distribution function using the Boltzmann equation	Electron Kinetics	T, U, L	
ELECT	Northrop R&T Center William B. Lacina (213) 377-4811 X 362	To provide an analysis of electron kinetics for an arbitrary gas mixture (possibly including excited species) as a function of electric field	Electron Kinetics	T, U, L	
ELENDIF	AFWAL CPT Gary L. Duke (513) 255-2923	To compute electron distribution function, mean electron energy drift velocity, and rate coefficient	Electron Kinetics	T, U, L	
ETRANV	Air Force Institute of Technology LTC William F. Bailey (513) 255-2012	To provide time dependent solution of master equation for vibrational energy exchange for modeling of vibrational-rotational laser systems	Laser Kinetics (General)	RP	
FREESL	R&D Associates Peter Crowell (505) 844-3013	To compute development of free shear layer at interface of primary cavity flow and secondary injected beam duct flow in a confined channel	Cavity Gas Dynamics	T, L	
GALERK	Joint Inst. for Lab. Astrophysics L. C. Pitchford** (303) 492-8255	To predict electron transport and excitation-ionization coefficients from cross-section data	Electron Kinetics	L, RP	
HGX80	United Technologies Research Center William L. Nighan (203) 727-7596	To compute laser discharge properties in electrically excited rare-gas halide and mercury-halide lasers	Plasma Kinetics (Excimers)	L, RP	Discharge Model
ILLOPT	Westinghouse R&D Center Johanna Schruben (412) 256-3611	Illumination evaluation and optimization of optical systems	General Optics	T	P
KINBOLTZ	Tetra Corp. Henry J. Happ, III (505) 256-3595	To compute the time dependent population levels in upper and lower states from rate equations	Plasma Kinetics (Excimers)	U, L	Time-Depend. Discharge Model
KINETIC	Lawrence Livermore Laboratory W. Lowell Morgan (415) 422-6289	To model the basic laser kinetics for E-Beam pumped and discharge lasers	Laser Kinetics (Excimers)	L	
KRF	TRW Jeanette Betts (213) 536-1453	To model KrF lasers and amplifiers	Laser Kinetics (KrF)	L	P
LAGAD	Westinghouse R&D Center Martin J. Pechersky (412) 256-7353	To compute non-steady gas-dynamics resulting from discharge heating and flow loop heat exchanger in a closed cycle system	System Gas Dynamics	L	P

*T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

**Now at Sandia Laboratory.

(Continued)

Table 1 (Continued)

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
LASER	Northrop R&T Center William B. Lacina (213) 377-4811 X 362	General laser kinetics synthesis and analysis for a broad class of transient, electrically excited laser systems	Laser Kinetics (Excimers)	T, U, L	
LASIM	Westinghouse R&D Center L. E. Kline (412) 256-7552	Simulation of UV initiated self-sustained discharge pumped XeF lasers	Laser Kinetics (XeF)	L, RP	
MOC	U. of Alabama in Huntsville C. C. Shih (205) 895-6330	To compute transient flow associated with sudden energy deposition characteristic of pulsed laser operations	Cavity Gas Dynamics	RP	
NRL LASER	Naval Research Lab. Louis J. Palumbo (202) 767-2255	Modeling of a variety of high power gas lasers. Mostly rare gas halides	Laser Kinetics (Excimers)	T, L, RP	
OPTEX	Westinghouse R&D Center Dennis Suhre (412) 256-7353	To predict the lasing outputs for the 10 μm P(14) and P(18) lines for a pulsed TEA laser	Laser Kinetics (CO_2)	T	P
POSEIDON	Poseidon Research James H. Morris (213) 341-9172	To model 1-D flow and acoustics in laser cavity and acoustic attenuation subsystem. (A 2-D version also exists.)	Cavity Gas Dynamics	T, RP	
PSI LASER	Physical Science, Inc. Paul Lewis (617) 933-8500 also Raymond Taylor (617) 546-7798	A series of general kinetics codes for cavity gain and power output calculations	Laser Kinetics (Excimers)	RP	
REDAC	Rocketdyne E. Wheatley (213) 709-7136	To model PFN performance	PFN	U	P
STROBE	R&D Associates Bruce Masson (505) 243-5609	To model beam duct, cavity acoustics	Cavity Gas Dynamics	T, L	
SUPER-SONIC	Northrop R&T Center William B. Lacina (213) 377-4811 X 362	Analysis of an electrically excited supersonic flow CO laser	Laser Kinetics (CO)	T, U, L	
TDFI-EDL	Lockheed-Huntsville Jürgen Thoenes (205) 837-1800	To estimate performance trends of a CW EDL with unstable resonator	Laser Kinetics (CO_2)	T, U	Coupled Optics Kinetics and Gas Dynamics
TEA	Westinghouse R&D Center Lyle Taylor (412) 256-5833	To model the laser kinetics of a pulsed 10.6 μm CO_2 laser and to predict its performance	Laser Kinetics (CO_2)	T, U	
TELSAT	R&D Associates Earl White (505) 844-8446	To study steady state and transient thermodynamic and fluid dynamic system performance	System Gas Dynamics	T, L, RP	

*T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

(Continued)

Table 1 (Concluded)

Code Name	Residing Organization Key Contact	Principal Purpose of Code	Code Classification	Documentation*	Comment
UNSEDL2	AFWL CPT Ted Salvi (505) 844-0256	Time dependent behavior of CW CO_2 EDL with mode-media instability	Laser Kinetics (CO_2)	T, U, L	Coupled Optics, Kinetics and Gas Dynamics
UVLZR	Los Alamos Sci. Lab. Arthur E. Greene (505) 667-7799	To study kinetics of rare gas halide lasers, design more efficient PFNs	Laser Kinetics (Excimer)	RP	Coupled to PFN
VIBKIN	Boeing Aerospace Co. Donald J. Nelson (206) 773-1498	To model the kinetics of an electric discharge pumped supersonic CO laser	Laser Kinetics (CO)	T, U, L	
XENON	U. of Illinois T. DeTemple (217) 333-3094	Synthesis of E-Beam initiated Ar-Xe laser	Laser Kinetics (Excimer)	RP	

*T = theory, U = user's manual, L = listing, RP = related publication, P = proprietary.

Table 2

SUMMARY OF LASER KINETICS CODES

This table summarizes the 21 laser kinetics codes surveyed. Listed under each code are information pertaining to: gas systems treated; type of operation; method of initiation treated in each code as well as comments.

Table 2

SUMMARY OF LASER KINETICS CODES

Code Name (Org.)	Gas System Treated	Type of Operation	Method(s) of Initiation	Comments
BMLASE (Westinghouse)	CO_2	Pulsed	Self-Sustained UV-Initiated	
COLASE (Westinghouse)	CO	Pulsed	Self-Sustained UV-Initiated	
EBEAM (MICOM)	CO_2	Pulsed	E-Beam Self-Sustained	Discharge Non-Uniformity Treated
EDLAMP (Lockheed)	CO_2	Pulsed, CW	E-Beam Controlled	Close Cycle Decontamination Treated
EDLNOD (AFWL)	CO_2	Pulsed	E-Beam	
EDLSL (AFWL)	CO_2	Pulsed	Self-Sustained	
ETRANV (AFIT)	CO_2, CO HF/DF	Pulsed, CW	E-Beam Self-Sustained	
KINETIC (LLL)	Excimers	Pulsed	E-Beam Self-Sustained UV-Initiated	Boltzmann Solver Included Extensive Graphics
KRF (TRW)	KrF	Pulsed	E-Beam	
LASER (Northrop)	Excimers	Pulsed	E-Beam Self-Sustained UV-Initiated	Boltzmann Solver Included Widely Distributed Code
LASIM (Westinghouse)	XeF	Pulsed	Self-Sustained UV-Initiated	
NRL LASER (NRL)	Excimers	Pulsed, CW	E-Beam Self-Sustained UV-Initiated	Boltzmann Solver Included Reaction Scheme Specified Using Symbolic Names for Reactants and Products
OPTEX (Westinghouse)	CO_2	Pulsed		10 μm P(14) and P(18) Lasing Output Predicted
PSI LASER (PSI)	Excimers	Pulsed, CW	E-Beam Self-Sustained	A Series of General Kinetics
SUPERSONIC (Northrop)	CO	Pulsed, CW		1-D Gas Dynamics
TDFI-EDL (Lockheed)	CO_2	CW	E-Beam	1-D Gas Dynamics, Physical Optics
TEA (Westinghouse)	CO_2	Pulsed, CW	E-Beam Self-Sustained	

(Continued)

Table 2 (Concluded)

Code Name (Org.)	Gas System Treated	Type of Operation	Method(s) of Initiation	Comments
UNSEDL2 (AFWL)	CO_2	Pulsed, CW	E-Beam	2-D Gas Dynamics, Physical Optics
UVLZR (LASL)	Excimers	Pulsed	UV Preionized Electron Impact Avalanche	Coupled to PFN
VIBKIN (Boeing)	CO	Pulsed, CW	E-Beam Self-Sustained	
XENON (U. of Ill.)	Ar-Xe	Pulsed	E-Beam Self-Sustained	

Table 3

SUMMARY OF GAS DYNAMICS CODES

This table summarizes the seven gas dynamics codes surveyed. Listed under each code is information pertaining to: level of complexity; type of equations used; coordinate system; flow components treated, and special features.

Table 3

SUMMARY OF GASDYNAMIC CODES

Code Name (Org.)	Level of Complexity	Type of Equations Used	Coordinate System	Flow Components Treated	Special Features Modeled
CCUBE (UAH)	Algebraic Model	Viscous Compressible	1-D	Closed Cycle	HX Compressors Treated
FREESL (RDA)	Finite Difference	Viscous Compressible	2-D	Cavity Flow	Beam Duct Interface Modeled
LAGAD (Westinghouse)	Algebraic (MOC)	Compressible	1-D + Time	Closed Cycle	Single Pulse Acoustic Treated
MOC (UAH)	Finite Difference	Viscous Compressible	1-D + Time	Cavity Flow	Single Pulse Acoustic Treated
POSEIDON (Poseidon)	Finite Difference	Compressible	2-D + Time	Cavity Flow	Repetitive Pulse Acoustic for an Open System Can Be Treated
STROBE (RDA)	Finite Difference	Compressible	3-D + Time	Cavity, Beam Duct	Single Pulse Acoustic Treated
TELSAT (RDA)	Finite Difference	Compressible	1-D + Time	Closed Cycle	HX, Compressors Treated

4. DETAILED RETURN OF SURVEY QUESTIONNAIRES

This section presents in alphabetical order returned questionnaires of the 42 codes surveyed. The questionnaire for each code is organized in the order of GENERAL INFORMATION, KINETICS, GASDYNAMICS, and OPTICS. The information stated herein follows as close as possible to those provided. Since no technical information was provided on ELENDIF and REDAC, only general information is reported on these codes.

CODE NAME: BACPR TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED:

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To predict electron transport, excitation and ionization coefficients from cross-section data.

ASSESSMENT OF CAPABILITIES: A thoroughly tested code used by many laboratories. Useful for meanelectron energy from about twice thermal up to values at which energy loss to ionization is about 10% of input. Thoroughly documented.

ASSESSMENT OF LIMITATIONS: Not accurate when inelastic cross-sections are comparable with elastic cross-section or when energy input to ionization is comparable with total input.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: A. V. Phelps

Organization: Joint Institute for Laboratory Astrophysics

Address: U. of Colorado, Boulder, CO 80309

Phone: (303) 492-7850

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T & RP - L. S. Frost and A.V. Phelps, Phys. Rev. 127, 1621 (1962)
J. Sherman, J. Math. Analysis and Applications 1, 342 (1960).
L, U - P.E. Luft, JILA Information Center Report No. 14, Oct. 30 (1975)

STATUS:

Operational Currently?: X

Under Modification?:

Purpose(s): Some modifications have been made since Luft's report.

Ownership?:

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600 & CDC 6400

TRANSPORTABLE?: X

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

KINETICS CODE

CODE NAME: BACPR

1. CODE STRUCTURE

COORDINATE SYSTEM (√): NA

Cartesian: ______ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: ______ 2-D: ______ Uniform

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS: NA

Gain Vary Along Optical Axis: ______

Flow Direction: ______

KINETICS MODELED: Pulsed: ______ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ______

Implicit: ______

Others (specify): backward prolongation

REFERENCE OF METHOD USED:

Sherman

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0

Number of Negative Species: 1

Number of Neutral Species: ≤ 3

REACTION MECHANISM MODELED (√):

Primary Ionization: (Reference)

E-Beam: ______

Self-Sustained: ______

UV-Initiated: ______

Others (specify): ______

Secondary Ionization (Reference)

Attachment: ______

Detachment: ______

Ion-Ion Recombination: ______

Charge Transfer: ______

Dissociation/Recombination: ______

Others (specify): ______

Source of Rate Coefficients Used: Varying

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ______

E-Field: ✓

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: 0

Number of Species: 1 electrons

Number of Reactions: ______

Other Major Species Considered: ______

IMPACT EXCITATION MODELED (√):

(Reference)

Vibrational: ✓

Electronic: ✓

Others (specify): rotation

ENERGY TRANSFER MODES MODELED (√):

(Reference)

V-T: NA

V-R: ______

V-V: ______

Others (specify): ______

Lasing Transition: P-Branch: ______

R-Branch: ______

Single Line Model (√): ______

Multi-Line Model (√): ______

Assumed Rotational Population Distribution State (√):

Equilibrium: ______

Nonequilibrium: ______

Number of Laser Lines Modeled: ______

Source of Rate Coefficients Used in Code: ______

LINE PROFILE MODELS (√):

Doppler Broadening: NA

Collisional Broadening: ______

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): NA

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

CODE NAME: BMLASE TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the laser kinetics of a pulsed 14 μm or 16 μm CO_2 laser and to predict the performance of the laser.

ASSESSMENT OF CAPABILITIES: Can handle gas mixtures of CO_2: N_2: He: H_2O: H_2 at any temperature and pressure, and for any pulse length.

ASSESSMENT OF LIMITATIONS: Is one-dimensional, stable resonators, and assumes that the rotational and kinetic temperatures are the same.

OTHER UNIQUE FEATURES: The lowest eight vibrational levels are treated exactly, and the population of the rotational level involved in the lasing is not assumed to be in equilibrium with the other rotational level populations.

ORIGINATOR/KEY CONTACT:

Name: Lyle Taylor

Organization: Westinghouse Electric Corporation

Address: 1310 Beulah Rd., Pittsburgh, PA 15668

Phone: 412-327-5833

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: W.H. Kaszer, D.W. Feldman, R.B. Feldman, D.R. Suhre, L.H. Taylor, G.L. Unger, and S.A. Wultzke, "Operational Characteristics of 16 μm CO_2 Laser," Westinghouse Report 80-1C2-OCCOL-R1 (1980).

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Westinghouse

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): U-1106

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: none

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	51400	3600 sec, U-1106
Large Job:		

Approximate Number of FORTRAN Lines: 2080

COMMENTS:

Fabry-Perot Cavity modeled using geometric optics and floating gain.

KINETICS CODE

CODE NAME: BMLASE

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: No

Flow Direction: No

KINETICS MODELED: Pulsed: ____ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ____

Implicit: ____

Others (specify): Hamming

REFERENCE OF METHOD USED: R.W. Hamming, Numerical Methods for Engineers and Scientists, (1962).

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ____

Number of Negative Species: ____

Number of Neutral Species: ____

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:	✓	
UV-Initiated:	✓	

Others (specify): ____

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/Recombination:		

Others (specify): ____

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ____

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: 5

Number of Reactions: 58

Other Major Species Considered: N_2, He, H_2O, H_2

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	
Electronic:	✓	

Others (specify): ____

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:	✓	
V-V:	✓	

Others (specify): ____

Lasing Transition: P-Branch: ✓

R-Branch: ✓

Single Line Model (√): ____

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ✓

Number of Laser Lines Modeled: 4

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ✓

Collisional Broadening: ✓

Others (specify): Voigt Profiles are used.

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: BOLTZ TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED: Overall System Characteristics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Given a homogenous isotropic gas mixture with a uniform applied DC field, code calculated the e^- distribution function and thus the forward/reverse excitation pumping rates and the fractional power transfer for each process as well as transport proeprties. These rates can be used in a kinetics code to determine the time-varying population distribution.

ASSESSMENT OF CAPABILITIES: Given E/N, and a set of cross-sections, BOLTZ calculates all the above quantities. Code has a variable number of bins for integrating, can include variable number of gases, super-elastic and electron-electron collisions.

ASSESSMENT OF LIMITATIONS: Number of energy bins & inelastic processes are limited by computer storage. Physical model is valid for fractional ionization up to 10^{-2} and fractional power into ionization and dissociation $\leq 10\%$. Convergence is difficult for superelastic-dominated cases.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: CPT Gary L. Duke

Organization: AFWAL/POOC-3

Address: Wright-Patterson AFB, Dayton, OH 45433

Phone: (513) 255-2923

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Code is well documented with comment cards (U); TETRA-TR-78-001."BOLTZ a code to solve the BOLTZMANN Electron Transport Eq " Henry J. Happ, III, Rettig Bennedict, Jr.,William P. Bailey, 1978.

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s):

Ownership?: AFWAL/POOC

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CYBER 175 and CYBER 74

TRANSPORTABLE?: Probably

Machine Dependent Restrictions: Programmed in Fortran IV

SELF-CONTAINED?: yes

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	50K	10 sec (10 diff E/N's input)
Typical Job:	100K	20 sec (10 diff E/N's input)
Large Job:	150K	9 sec (3 diff E/N's input)

Approximate Number of FORTRAN Lines: 500

COMMENTS: NOTE: BOLTZ is an electron kinetics code, not a gas kinetics code. As yet it is not linked to any other kinetic or chemistry type code.

KINETICS CODE

CODE NAME: BOLTZ

I. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ____

KINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ____

Implicit: ____

Others (specify): ____

REFERENCE OF METHOD USED: Simpson Integration

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ____

Number of Negative Species: electrons only

Number of Neutral Species: any number

REACTION MECHANISM MODELED (√):

Primary Ionization: (Reference)

E-Beam: ____

Self-Sustained: ____

UV-Initiated: ____

Others (specify): ____

Secondary Ionization (Reference)

Attachment: ____

Detachment: ____

Ion-Ion Recombination: ____

Charge Transfer: ____

Dissociation/Recombination: ____

Others (specify): ____

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ✓ E/N input

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: ____

Number of Species: ____

Number of Reactions: ____

Other Major Species Considered: Rotational, attachment, dissociation, ionization (all empact)

IMPACT EXCITATION MODELED (√):

(Reference)

Vibrational: ____

Electronic: ____

Others (specify): ____

ENERGY TRANSFER MODES MODELED (√):

(Reference)

V-T: ____

V-R: ____

V-V: ____

Others (specify): ____

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ____

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ____

Number of Laser Lines Modeled: ____

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: CCUBE TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Cavity, Diffuser, Heat Exchangers, Compressior

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Computes the flow properties throughout a closed circulator for a steady state cw laser.

ASSESSMENT OF CAPABILITIES: Temperature dependent gas properties are modeled.

ASSESSMENT OF LIMITATIONS:

OTHER UNIQUE FEATURES: Can be used to investigate various design configurations.

ORIGINATOR/KEY CONTACT:

Name: G. R. Karr and C. C. Shih

Organization: Mech. Eng. Dept., Univ. of Ala. in Huntsville

Address: Huntsville, AL 35809

Phone: (205) 895-6330, (205) 895-6075, or (205) 895-6145

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Analysis of Laser Gas Circulation Systems, UAH Report 164, 1975 Shih, Karr, Cleland and Laube.

Shih & Karr, Investigation of Transient Flow and Heating Problems Characteristic of High Energy Laser Circulation Systems, UAH, Report No. 199, 1977.

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Continuous changing code used to investigate designs of current interest.

Ownership?: UAH

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1108

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none

SELF-CONTAINED?:

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		order of 100 sec.
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: 1 box cards

COMMENTS:

GAS DYNAMICS CODE

CODE NAME: CCUBE

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: ✓ Expanding: ____
   - FLUID GRID DIMENSIONALITY (√):
     - 1-D: ✓
     - 2-D: ____
     - 3-D: ____
     - Time Dependent: ____
   - FLOW FIELD MODELED (√):
     - Compressible Flow: ✓
     - Incompressible: ____
     - Viscous Flow: ✓
     - No Flow: ____
   - BASIC MODELING APPROACH (√):
     - Algebraic: ✓ Integral Method: ____
     - Finite Difference: ____
     - Others (specify): ____

   REFERENCE FOR APPROACH USED: ____

2. GAS DYNAMICS MODEL FEATURES:
   - GAS SUPPLY MODELED (√):
     - Mixture Preparation: ✓
     - Mixture Injection: ____
       - Nozzles: ____
       - Flow Plates: ____
       - Others (specify): ____

   CAVITY INITIAL CONDITION DETERMINED BY (specify): Calculated as steady state.

3. EXHAUST/RECIRCULATION MODEL
   - GENERAL SYSTEM MODELED (√):
     - Open System: ____ Closed System: ____
     - Closed Cycle: ✓
   - EXHAUST SYSTEM FEATURES (√):
     - Pressure Recovery: ____
     - Ejector System: ____
     - Compressor/Fan: ✓
     - Heat Exchanger: ✓
     - Gas Make-Up: ____
     - Others (specify): ____

DECONTAMINATION METHOD TREATED (√):
- Scrubber: ____
- Shower: ____
- Catalytic Reactor: ____
- Others (specify): ____

4. ACOUSTIC ATTENUATION MODEL
   - GENERAL FEATURES MODELED (√):
     - Single Pulse: ____ Repetitive Pulse: ____
   - DIMENSIONALITY TREATED (√):
     - 1-D: ____ 2-D: ____ 3-D: ____
     - Time-Dependent: ____
   - DISTURBANCE MODELED (√):
     - Pressure Wave: ____ Entropy Wave: ____
     - Others (specify): ____
   - WAVE PROPAGATION TREATMENT (√):
     - Linear Wave: ____
     - Nonlinear Wave: ____
     - Others (specify): ____
   - THEORETICAL BASIS: (Reference) ____
   - NUMERICAL METHODOLOGY: (Reference) ____
   - ACOUSTIC ATTENUATORS CONSIDERED (√):
     - Muffler: ____ Heat Exchanger: ____
     - Horn: ____ Porous Wall: ____
     - Others (specify): ____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):
   - Index of Refraction Variation?: ____
   - Other (specify): ____

OTHER UNIQUE FEATURES: ____

CODE NAME: COLASE TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the laser kinetics of a pulsed, electric discharge CO laser and to predict the performance of the laser. This code is a modification of the code developed for CW lasers by William B. Lacina of the Northrop Corporation.

ASSESSMENT OF CAPABILITIES: Can handle gas mixtures of CO: N_2: Ar: He: Xe: O_2 at any temperature and pressure and excited by an electric discharge.

ASSESSMENT OF LIMITATIONS: The model is one-dimensional, can only model stable resonators, and assumes the same temperature for rotational and kinetic energies.

OTHER UNIQUE FEATURES: Includes superelastic collisions and discharge kinetics, and has sophisticated output formats.

ORIGINATOR/KEY CONTACT:

Name: Lyle Taylor

Organization: Westinghouse Electric Corporation

Address: 1310 Beulah Rd., Pittsburgh, PA 15668

Phone: 412-256-5833

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: S.A. Wutzke, D.R. Suhre, L.H. Taylor, L.E. Kline, R.R. Mitchell and M.J. Pechersky, "UV Photoionized CO Electric Laser Research", Westinghouse Report 77-9C2-COLAS-R2 (1977).

U: L.H. Taylor and R.R. Mitchell " User's Manual for an Electric Discharge CO Laser Kinetics Code, "Westinghouse Report 77-9C2-COLAS-R1 (1977).

STATUS:

Operational Currently?: no

Under Modification?: no

Purpose(s):

Ownership?: U. S. Government

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): U-1106 and CDC-7600

TRANSPORTABLE?: no

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	340,000	60 sec, CDC-7600
Large Job:		

Approximate Number of FORTRAN Lines: 6878

COMMENTS:

Fabry-Perot cavity model using floating gain, geometric optics.

KINETICS CODE

CODE NAME: COLASE

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: no

Flow Direction: no

KINETICS MODELED: Pulsed: ✓ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ____

Implicit: ____

Others (specify): Simpson's Rule

REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 6

Number of Negative Species: 6

Number of Neutral Species: 6

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:	✓	
UV-Initiated:	✓	
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/ Recombination:		
Others (specify):		

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ____

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO

Number of Species: 6

Number of Reactions: 10

Other Major Species Considered:

N_2, Ar, He, Xe, O_2

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	
Electronic:	✓	
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:		
V-V:	✓	

Others (specify): ____

Lasing Transition: P-Branch: ✓

R-Branch: ✓

Single Line Model (√): ____

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ____

Number of Laser Lines Modeled: 40

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ✓

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): None

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: DENSITY TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: None, other than a simple RLC circuit

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Determine the time dependent species concentrations, voltage, and current in XeCl laser plasma. Program is centered around a subroutine DGEAR from the International Mathematics and Science Library (IMSL) for CDC 6600 computers. DGEAR is a subroutine for solving stiff differential equations.

ASSESSMENT OF CAPABILITIES: Currently tracks 7 species, plus voltage and current. Requires 110K of storage, 32K of which is a plotting routine. It takes $\sim$7 sec. to calculate 500 time increments. This really depends upon how stiff the equations are.

ASSESSMENT OF LIMITATIONS: Code is presently awkward to change the number of equations. Code requires data bank of rates.

OTHER UNIQUE FEATURES: The electron kinetic rates are generally calculated by a separate code called BOLTZ which is not yet linked to DENSITY. These rates are interpolated using a SPLINE fit.

ORIGINATOR/KEY CONTACT:

Name: CPT Gary L. Duke

Organization: AFWAL/POOC-3

Address: Wright-Patterson AFB, OH 45433

Phone: (513) 255-2923 or (513) 255-3835

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): None on Density

DGEAR is described in the IMSL description or in:

1. Hindmarch, A.C. "GEAR: Ordinary Differential Equation System Solver," Lawrence Livermore Lab. Report UCID-30001, Rev. 3, Dec 74.

2. GEAR, C.W. Numerical Initial Value Problems in Ordinary Differential Eqs, Prentice-Hall, Engelwood Cliffs, New Jersey, 1971.

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): To increase the number of species, update rates, and link to BOLTZ. code. Also want to make the code have a variable time step dependent upon the voltage change.

Ownership?: U.S. Government

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 in FORTRAN

TRANSPORTABLE?: yes, if IMSL is available.

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): DGEAR involves still differntial equations.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	110K	3 sec
Typical Job:	110K	7 sec (500 time increments)
Large Job:	110K	20 sec

Approximate Number of FORTRAN Lines: 450 excluding DGEAR

COMMENTS:

KINETICS CODE

CODE NAME: DENSITY

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ____

KINETICS MODELED: Pulsed: ✓ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ____

Implicit: ____

Others (specify): DGEAR

REFERENCE OF METHOD USED: See description in Available Documentation

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 2

Number of Negative Species: 2

Number of Neutral Species: 3

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:	✓	only Townsend ionization
UV-Initiated:		
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:		
Ion-Ion Recombination:	✓	
Charge Transfer:		
Dissociation/ Recombination:	✓	
Others (specify):		

Source of Rate Coefficients Used: Current literature

DISCHARGE POWER INPUT MODELED (√):

Uniform: ____ Non-Uniform: ____

E-Field: ____

Others (specify): LRC circuit

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: XeCl

Number of Species: 1

Number of Reactions: 2

Other Major Species Considered: Xe^*, Xe^+, Xe_2^+, Cl^-, HCl ($\nu=1$)

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	HCl
Electronic:	✓	Xe
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	Collisional relaxation rate const.
V-R:		
V-V:		

Others (specify): ____

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ____

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ____

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: E-Beam Transport TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Discharge gap including the foil, cathode, and the anode

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The code is developed to model the E-beam transport in the 2-D discharge gap of an EDL under prescribed E-field and B-field. It computes the E-beam energy deposition distribution. When it is coupled to the PLASMA TRANSPORT CODE, accurate E-field and ionization distributions can be obtained.

ASSESSMENT OF CAPABILITIES: Although this code was written for the beam-electron energies between 5 to 500 keV, the energy range can be extended by adding more loss mechanisms and changing the cross sections. Discharge geometry can also be altered.

ASSESSMENT OF LIMITATIONS: At the present time, discharge cavities with dielectric flow plate and E-beam shield cannot be handled; field penetration in the region between the foil and the cathode is ignored.

OTHER UNIQUE FEATURES: Semi-analytical and semi-empirical formulas will be used to speed up the computation. Provision will be made for estimating the space charge arising from thermalization of the backscattered E-beam..

ORIGINATOR/KEY CONTACT:

Name: T.K. Tio

Organization: R & D Associated

Address: P.O. Box 9695, Marina del Rey, CA 90291

Phone: (213) 822-1715 ext. 448

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Permission from AFWL is required to obtain the following documents.

1. EDL Discharge Modeling Status Report (T)
2. LASL Monte-Carlo Electron Transport Codes, Pts. I & II (Flow Charts)
3. Using the LASL Monte-Carlo Electron Transport Codes (U,L)

STATUS:

Operational Currently?: not ready

Under Modification?: yes

Purpose(s): To speed up the code by incorporating semi-analytic and semi-empirical formulas; to sample the space charges arising from the backscattered E-beam.

Ownership?: RDA

Proprietary?: Permission from AFWL is required.

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1

TRANSPORTABLE?: yes

Machine Dependent Restrictions: Core size, FORTRAN Language

SELF-CONTAINED?:

Other Codes Required (name, purpose): Poisson equation solver is required to iterate for the E-field.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	200,000	250 (for 1,000 particles)
Typical Job:	200,000	1,250 (for 5,000 particles)
Large Job:	200,000	2,500 (for 10,000 particles)

Approximate Number of FORTRAN Lines: 12,000

COMMENTS:

KINETICS CODE

CODE NAME: E-Beam Transport

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: √ Expanding: ____
   - KINETICS GRID DIMENSIONALITY (√):
     - 1-D: ____ 2-D: √
     - 3-D: ____
   - GAIN REGION SYMMETRY RESTRICTIONS:
     - Gain Var. Along Optical Axis: ____
     - Flow Direction: ____
   - KINETICS MODELED: Pulsed: ____ CW: ____
   - NUMERICAL SCHEME USED IN RATE CALCULATION (√):
     - Explicit: ____
     - Implicit: ____
     - Others (specify): ____
   - REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL
   - NUMBER OF SPECIES TREATED (specify):
     - Number of Positive Species: ____
     - Number of Negative Species: ____
     - Number of Neutral Species: ____
   - REACTION MECHANISM MODELED (√):
     - Primary Ionization: (Reference)
       - E-Beam: √
       - Self-Sustained: ____
       - UV-Initiated: ____
     - Others (specify): ____
     - Secondary Ionization (Reference)
       - Attachment: ____
       - Detachment: ____
       - Ion-Ion Recombination: ____
       - Charge Transfer: ____
       - Dissociation/Recombination: √
       - Others (specify): ____
     - Source of Rate Coefficients Used: AERL's experimental values
   - DISCHARGE POWER INPUT MODELED (√):
     - Uniform: ____ Non-Uniform: √
     - E-Field: √
     - Others (specify): ____

3. LASING KINETICS MODEL
   - GENERAL (specify):
     - Lasing Species: ____
     - Number of Species: ____
     - Number of Reactions: ____
     - Other Major Species Considered: ____
   - IMPACT EXCITATION MODELED (√): (Reference)
     - Vibrational: ____
     - Electronic: ____
     - Others (specify): ____
   - ENERGY TRANSFER MODES MODELED (√): (Reference)
     - V-T: ____
     - V-R: ____
     - V-V: ____
     - Others (specify): ____
     - Lasing Transition: P-Branch: ____
       - R-Branch: ____
     - Single Line Model (√): ____
     - Multi-Line Model (√): ____
       - Assumed Rotational Population Distribution State (√):
         - Equilibrium: ____
         - Nonequilibrium: ____
       - Number of Laser Lines Modeled: ____
     - Source of Rate Coefficients Used in Code: ____
   - LINE PROFILE MODELS (√):
     - Doppler Broadening: ____
     - Collisional Broadening: ____
     - Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√):
   - O_x: ____ OH_x: ____
   - NO_x: ____ HNO_x: ____
   - Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: EBEAM TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity, Lasing Gas, Electrical Power

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Compute time history of electric laser output power output for EBEAM or axial lasers. Input requires electric power input, laser cavity specifications, and gas species and densities.

ASSESSMENT OF CAPABILITIES: The code is compact and fast. Output values compare favorably with experimental values.

ASSESSMENT OF LIMITATIONS: Kinetics are approximated to speed the computations. Therefore, gas species limited to CO_2, He, N2, and water vapor.

OTHER UNIQUE FEATURES: Gain spike values are computed.

ORIGINATOR/KEY CONTACT:

Name: Arthur Werkheiser

Organization: U. S. Army Missile Command

Address: DRSMI-RHA Directed Energy Directorate, Redstone Arsenal, AL 35898

Phone: (205) 876-8161

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): Formal documentation being assembled. Informally, there is available listing and user's manual.

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Attempting a two-dimensional representation of the output.

Ownership?: U. S. Army

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): no

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	30K	10 sec
Large Job:		

Approximate Number of FORTRAN Lines: 500

COMMENTS:

KINETICS CODE

CODE NAME: EBEAM

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: ✓ Expanding: ____
   - KINETICS GRID DIMENSIONALITY (√):
     - 1-D: ✓ 2-D: ____
     - 3-D: ____
   - GAIN REGION SYMMETRY RESTRICTIONS:
     - Gain Vary Along Optical Axis: ____
     - Flow Direction: ____
   - KINETICS MODELED: Pulsed: ✓ CW: ____
   - NUMERICAL SCHEME USED IN RATE CALCULATION (√):
     - Explicit: ____
     - Implicit: ✓
     - Others (specify): ____
   - REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL
   - NUMBER OF SPECIES TREATED (specify):
     - Number of Positive Species: ____
     - Number of Negative Species: ____
     - Number of Neutral Species: ____
   - REACTION MECHANISM MODELED (√):
     - Primary Ionization: (Reference)
       - E-Beam: ✓
       - Self-Sustained: ✓
       - UV-Initiated: ____
     - Others (specify): ____
     - Secondary Ionization (Reference)
       - Attachment: ✓
       - Detachment: ____
       - Ion-Ion Recombination: ✓
       - Charge Transfer: ____
       - Dissociation/ Recombination: ✓
       - Others (specify): ____
       - Source of Rate Coefficients Used: ____
   - DISCHARGE POWER INPUT MODELED (√):
     - Uniform: ____ Non-Uniform: ____
     - E-Field: ____
     - Others (specify): all three can be selected.

3. LASING KINETICS MODEL
   - GENERAL (specify):
     - Lasing Species: CO_2
     - Number of Species: 3
     - Number of Reactions: ____
     - Other Major Species Considered: ____
   - IMPACT EXCITATION MODELED (√):
     - (Reference)
     - Vibrational: ____
     - Electronic: ____
     - Others (specify): not explicitly defined
   - ENERGY TRANSFER MODES MODELED (√):
     - (Reference)
     - V-T: ____
     - V-R: ✓
     - V-V: ✓
     - Others (specify): not explicitly defined
     - Lasing Transition: P-Branch: ____
       - R-Branch: ____
     - Single Line Model (√): ✓
     - Multi-Line Model (√): ____
       - Assumed Rotational Population Distribution State (√):
         - Equilibrium: ____
         - Nonequilibrium: ✓
       - Number of Laser Lines Modeled: 1
     - Source of Rate Coefficients Used in Code: ____
   - LINE PROFILE MODELS (√):
     - Doppler Broadening: ____
     - Collisional Broadening: ____
     - Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√):
   - O_x: ____ OH_x: ____
   - NO_x: ____ HNO_x: ____
   - Others (specify): not specified
   - REFERENCE FOR REACTION MECHANISM AND RATES: ____
   - OTHER UNIQUE FEATURES: ____

CODE NAME: EBEAM2 TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Power Supply

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Given power supply specifications for an E-Beam laser, computes the E-Beam gun and sustainer voltage and current time history. Gas species and densities are also inputted.

ASSESSMENT OF CAPABILITIES: Provides a graphical display of current and voltage for each of the two electrical systems in a pulsed E-beam laser.

ASSESSMENT OF LIMITATIONS: Restricted to CO_2, N_2 and HE Gas Systems. Laser outputted not computed.

OTHER UNIQUE FEATURES: was used in a comparison between theory and experiment. Easily showed gas rate coefficient dependencies.

ORIGINATOR/KEY CONTACT:

Name: Arthur Werkheiser

Organization: US Army Missile Command

Address: DRSMI-RHA, Directed Energy Directorate, Redstone Arsenal, AL 35898

Phone: (205) 876-8161

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

Under preparation.

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s):

Ownership?: US Army

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): DEC PDP 11/34

TRANSPORTABLE?: no

Machine Dependent Restrictions: Requires a Tektronics 4012 terminal

SELF-CONTAINED?:

Other Codes Required (name, purpose): Requires Tektronics Plot 10 Software

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	25K	
Large Job:		

Approximate Number of FORTRAN Lines: 300

COMMENTS:

KINETICS CODE

CODE NAME: EBEAM2

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: ______ 2-D: ______

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ______

Flow Direction: ______

KINETICS MODELED: Pulsed: ✓ CW: ______

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ______

Implicit: ✓

Others (specify): ______

REFERENCE OF METHOD USED: ______

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ______

Number of Negative Species: ______

Number of Neutral Species: ______

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:		
UV-Initiated:		

Others (specify): ______

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:	✓	
Charge Transfer:		
Dissociation/ Recombination:		

Others (specify): ______

Source of Rate Coefficients Used: ______

DISCHARGE POWER INPUT MODELED (√):

Uniform: ______ Non-Uniform: ✓

E-Field: ______

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: 1

Number of Species: 3

Number of Reactions: ______

Other Major Species Considered: ______

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:		
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:		
V-R:		
V-V:		

Others (specify): ______

Lasing Transition: P-Branch: ______

R-Branch: ______

Single Line Model (√): ______

Multi-Line Model (√): ______

Assumed Rotational Population Distribution State (√):

Equilibrium: ______

Nonequilibrium: ______

Number of Laser Lines Modeled: ______

Source of Rate Coefficients Used in Code: ______

LINE PROFILE MODELS (√):

Doppler Broadening: ______

Collisional Broadening: ______

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

CODE NAME: EBM2D TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity, Gas

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: EBM2D Computes a 2-dimensional distribution of electron density, electric field, and power deposited within a laser cavity for a given potential difference and current density for electric lasers.

ASSESSMENT OF CAPABILITIES: Computes using attachment coefficient, Townsend avalanche, and recombination coefficients. A fast, compact code.

ASSESSMENT OF LIMITATIONS: Reiterates 6 times in computing one distribution. Does not give a time history. Restricted to a few species.

OTHER UNIQUE FEATURES: Makes use of cavity symmetry. Includes several empiracal approximations to speed the calculations. Presupposes an EBEAM. laser.

ORIGINATOR/KEY CONTACT:

Name: Arthur Werkheiser

Organization: U.S. Army Missile Command

Address: DRSMI-RHA Directed Energy Directorate, Redstone Arsenal, AL 35898

Phone: (205) 876-8161

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): E-Beam Spreading and Resulting Field Variations in CO_2 Laser Plasmas, Cason, C., Perkins, J.F. and Werkheiser, A.H., AIAA Journal, Vol. 15, No. 8, Aug. 1977, pp. 1079 - 1083 (T)

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Combining this with EBEAM to produce a two-dimensional time history.

Ownership?: US Army

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions: no

SELF-CONTAINED?:

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	30K	15 sec
Large Job:		

Approximate Number of FORTRAN Lines: 400

COMMENTS:

KINETICS CODE

CODE NAME: EBM2D

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: ______ 2-D: ✓

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ______

Flow Direction: ______

KINETICS MODELED: Pulsed: ______ CW: ______

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ______

Implicit: ✓

Others (specify): ______

REFERENCE OF METHOD USED: ______

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ______

Number of Negative Species: ______

Number of Neutral Species: ______

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:		
UV-Initiated:		
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:	✓	
Charge Transfer:		
Dissociation/ Recombination:	✓	
Others (specify):		

Source of Rate Coefficients Used: ______

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ______

E-Field: ______

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: 3

Number of Reactions: ______

Other Major Species Considered: ______

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:		
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:		
V-R:		
V-V:		

Others (specify): ______

Lasing Transition: P-Branch: ______

R-Branch: ______

Single Line Model (√): ✓

Multi-Line Model (√): ______

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ______

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: ______

LINE PROFILE MODELS (√):

Doppler Broadening: ______

Collisional Broadening: ______

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

CODE NAME: EDLAMP TECHNICAL AREA(S): Kinetics, Gas Dynamics

DEVICE COMPONENTS TREATED: Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE:

Cavity Performance

ASSESSMENT OF CAPABILITIES: Suited for any E-Beam controlled EDL

ASSESSMENT OF LIMITATIONS: One-D Only (Flow distance for CW applications, time for pulsed application)

OTHER UNIQUE FEATURES: Detailed Plasma Kinetics; code can model kinetics effects due to recirculation on performance.

ORIGINATOR/KEY CONTACT:

Name: Jurgen Thoenes

Organization: Lockheed-Huntsville Research & Engineering Center

Address: P. O. Box 1103, Huntsville, AL 35807

Phone: (205) 837-1800, ext. 416

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: J. Thoenes, S.C. Kurzius, "Plasma Chemistry Processes in the Closed Cycle EDL", MICOM TR DRCPM-HEL-CR-79-11, 1979, Vol. I.

U: J. Thoenes, "EDLAMP User's Manual", MICOM TR DRCPM-HEL-CR-79-11, Vol. II, 1979.

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s):

Ownership?: Lockheed & U.S. Army, MICOM

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 (MICOM), CYBER 176 (AFWL)

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none for CDC Computers

SELF-CONTAINED?:

Other Codes Required (name, purpose): Boltzmann Electron Kinetics Code.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	145K	60
Large Job:		

Approximate Number of FORTRAN Lines: 5000

COMMENTS:

Fabry-Perot cavity modeled using geometric optics.

KINETICS CODE

CODE NAME: EDLAMP

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ______

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ______

Flow Direction: ✓

KINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓

Implicit: ✓

Others (specify): ______

REFERENCE OF METHOD USED: ______

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Arbitrary

Number of Negative Species: Arbitrary

Number of Neutral Species: Arbitrary

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:		
UV-Initiated:		
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:	✓	
Charge Transfer:	✓	
Dissociation/ Recombination:	✓	
Others (specify):		

Source of Rate Coefficients Used: ______

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ______

E-Field: ✓

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: Arbitrary

Number of Reactions: Arbitrary

Other Major Species Considered:

N_2, He, O_2, H_2, CO

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	
Electronic:	✓	
Others (specify):	Ionization	

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:		
V-V:	✓	

Others (specify): ______

Lasing Transition: P-Branch: ✓

R-Branch: ✓

Single Line Model (√): ✓

Multi-Line Model (√): ______

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ______

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: ______

LINE PROFILE MODELS (√):

Doppler Broadening: ✓

Collisional Broadening: ✓

Others (specify):

Combination (Voigt Profile)

4. RECIRCULATION CONTAMINANTS MODELED (√):

O_x: ✓ OH_x: ✓

NO_x: ✓ HNO_x: ✓

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

GAS DYNAMICS CODE

CODE NAME: EDLAMP

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ______

FLUID GRID DIMENSIONALITY (√):

1-D: ✓

2-D: ______

3-D: ______

Time Dependent: ______

FLOW FIELD MODELED (√):

Compressible Flow: ✓

Incompressible: ______

Viscous Flow: ______

No Flow: ______

BASIC MODELING APPROACH (√):

Algebraic: ______ Integral Method: ______

Finite Difference: ✓

Others (specify): ______

REFERENCE FOR APPROACH USED: ______

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (√):

Mixture Preparation: ______

Mixture Injection: ______

Nozzles: ______

Flow Plates: ______

Others (specify): ______

CAVITY INITIAL CONDITION DETERMINED BY (specify): given ρ, T, U, Equil. concentrations

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (√):

Open System: ✓ Closed System: ______

Closed Cycle: ✓

EXHAUST SYSTEM FEATURES (√):

Pressure Recovery: ______

Ejector System: ______

Compressor/Fan: ______

Heat Exchanger: ✓

Gas Make-Up: ✓

Others (specify): Heat exchanger modeled via specified drop in T. Make-up modeled by adjusting mixture composition.

DECONTAMINATION METHOD TREATED (√):

Scrubber: ✓

Shower: ______

Catalytic Reactor: ✓

Others (specify): Scrubber/Catalytic reactor modeled by adjusting mixture composition.

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (√):

Single Pulse: ______ Repetitive Pulse: ______

DIMENSIONALITY TREATED (√):

1-D: ______ 2-D: ______ 3-D: ______

Time-Dependent: ______

DISTURBANCE MODELED (√):

Pressure Wave: ______ Entropy Wave: ______

Others (specify): ______

WAVE PROPAGATION TREATMENT (√):

Linear Wave: ______

Nonlinear Wave: ______

Others (specify): ______

THEORETICAL BASIS: (Reference) ______

NUMERICAL METHODOLOGY: (Reference) ______

ACOUSTIC ATTENUATORS CONSIDERED (√):

Muffler: ______ Heat Exchanger: ______

Horn: ______ Porous Wall: ______

Others (specify): ______

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):

Index of Refraction Variation?: ______

Other (specify): ______

OTHER UNIQUE FEATURES: ______

CODE NAME: EDLNOD TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Small signal gain and energy extraction for CO_2 EDL's.

ASSESSMENT OF CAPABILITIES: Both versions of this code have demonstrated good agreement with experimental data from Humdinger, ABEL, and the AFWL Pulsar Device.

ASSESSMENT OF LIMITATIONS: The energy extraction routine is not based on physical optics principles, so predictions are of limited utility. The code assumes uniform electric field and electron density.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: CPT Robert F. Walter

Organization: AFWL/AREP

Address: Kirtland AFB, NM 87117

Phone: 505-844-1786

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): L

RP: AFWL TR-74-216

J. Appl. Phys. 46, 3566, Aug. 1975

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Provide voltage and current input waveforms of arbitrary temporal profile.

Ownership?: US AirForce

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1 , CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): IDHHANK - Boltzmann Equation Code required to calculate electron excitation rates.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	(200,000)	2 sec. on CRAY
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

KINETICS CODE

CODE NAME: EDLNOD

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ____ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ____

KINETICS MODELED: Pulsed: ✓ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓

Implicit: ____

Others (specify): ____

REFERENCE OF METHOD USED: AFWL TR-74-216, J. Appl. Phys. 46, 3566, Aug. 1975

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0

Number of Negative Species: 1

Number of Neutral Species: 4

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:		
UV-Initiated:		

Others (specify): ____

Secondary Ionization		(Reference)
Attachment:		
Detachment:		
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/Recombination:		

Others (specify): ____

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ____

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: 1

Number of Species: 4

Number of Reactions: ____

Other Major Species Considered: ____

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	
Electronic:		
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:		
V-V:	✓	

Others (specify): ____

Lasing Transition: P-Branch: ✓

R-Branch: ____

Single Line Model (√): ✓

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ____

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code:

AFWL TR-74-216

LINE PROFILE MODELS (√):

Doppler Broadening: ✓

Collisional Broadening: ✓

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: EDLSL TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: CO_2/H_2 or He/ N_2 EDL Cavity Kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Models the Kinetics of photon production by a glow discharge in an EDL cavity containing CO_2, N_2 and H_2 or He using the 6-temperature model of AVCO written by Dr. A.T. Gavrielides of the AFWL.

ASSESSMENT OF CAPABILITIES: A fast and simple algorithm which does not account for E-beam spreading, has no optics in it, and assumes a constant average N_e which is an input.

ASSESSMENT OF LIMITATIONS: Has been anchored to other codes such as that of Lockheed and has shown agreement within 10-15%.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: A. T. Gavrielides

Organization: AFWL/LRE

Address: Kirtland AFB, N.M. 87106

Phone: (505) 844-4691

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): none

This is an "in-house" code used by a limited number of people.

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s):

Ownership?: AFWL/LRE

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600/ CYBER 176 NOSBE operating system

TRANSPORTABLE?: marginally

Machine Dependent Restrictions: Was written for CDC and is not in ANS11 Fortran

SELF-CONTAINED?:

Other Codes Required (name, purpose): Requires DISSPLA package and a library differential equation solver.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	4992	20 sec
Large Job:		

Approximate Number of FORTRAN Lines: ~ 150

COMMENTS:

KINETICS CODE

CODE NAME: EDLSL

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: ______ 2-D: ✓

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ______

Flow Direction: ✓

KINETICS MODELED: Pulsed: ✓ CW: ______

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ______

Implicit: ✓

Others (specify): ______

REFERENCE OF METHOD USED: AVCO 6-temp model programmed by Dr. A.T. Gavrielide of the AFWL.

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0

Number of Negative Species: 0

Number of Neutral Species: 3

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:	✓	AFRL Kinetics Handbook
UV-Initiated:		

Others (specify): ______

Secondary Ionization		(Reference)
Attachment:		
Detachment:		
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/Recombination:		

Others (specify): ______

Source of Rate Coefficients Used: ______

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ______

E-Field: ______

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: 3

Number of Reactions: 6

Other Major Species Considered: ______

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:		

Others (specify): ______

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:	✓	AVCO Handbook
V-V:	✓	

Others (specify): ______

Lasing Transition: P-Branch: ✓

R-Branch: ______

Single Line Model (√): ✓

Multi-Line Model (√): ______

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ______

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: ______

LINE PROFILE MODELS (√):

Doppler Broadening: ✓

Collisional Broadening: ______

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: Gain switch spike computed.

plotting capability.

CODE NAME: EED, also called BOLTZ TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED: NA

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: EED solves for the steady-state electron distribution function using the Boltzmann Equation. Elastics, Inelastic and Super-elastic interactions are considered, as well as electron-electron interactions.

ASSESSMENT OF CAPABILITIES: Very general. It will consider any gas as long as cross-section data for that gas are available. If no super-elastics or electron-electron interactions are included, the code is very fast.

ASSESSMENT OF LIMITATIONS: The electron-electron interactions are somewhat untested and it's not clear if the formulation is correct. If superelastics are included, the method is slow. Also, if superelastics are included a lot of core memory is required.

OTHER UNIQUE FEATURES: Very easy to use, clear output, very little machine-dependent features. Input is checked for consistency and validity.

ORIGINATOR/KEY CONTACT:

Name: Henry Happ

Organization: Tetra Corp.

Address: 1325 San Mateo, SE, Albuquerque, NM 87108

Phone: (505) 256-3595

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

Boltz: A code to solve the Boltzmann Electron Transport Equation, Tetra TR-78-001 (T,U)

Listings are available upon request.

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s):

Ownership?: U. S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 or 176, CRAY-1

TRANSPORTABLE?: Almost

Machine Dependent Restrictions: How the machine orders its display code. Problem only occurs in one or two lines of code. Also, write statements use A8 formats. /Finally, NAMELIST is used.

SELF-CONTAINED?:

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	32533 *	
Typical Job:	232433	
Large Job:	232533	

Approximate Number of FORTRAN Lines: 2400

COMMENTS: * If superelastics are to be included, a large array of size (256,256) is used. References to this array can be removed if superelastics are not used.

KINETICS CODE

CODE NAME: EBD

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: ✓ Expanding: ____
   - KINETICS GRID DIMENSIONALITY (√):
     - 1-D: ✓ 2-D: ____
     - 3-D: ____
   - GAIN REGION SYMMETRY RESTRICTIONS:
     - Gain Vary Along Optical Axis: ____
     - Flow Direction: ____
   - KINETICS MODELED: Pulsed: ____ CW: ____
   - NUMERICAL SCHEME USED IN RATE CALCULATION (√):
     - Explicit: ✓
     - Implicit: ____
     - Others (specify): ____
   - REFERENCE OF METHOD USED: Thomson, Smith & Davies, "Boltz: A Code...", Computer Phys. Comm., V.11, p. 369-383, 1976
2. PLASMA KINETICS MODEL
   - NUMBER OF SPECIES TREATED (specify):
     - Number of Positive Species: ____
     - Number of Negative Species: ____
     - Number of Neutral Species: ____
   - REACTION MECHANISM MODELED (√):
     - Primary Ionization: (Reference)
       - E-Beam: ____
       - Self-Sustained: ____
       - UV-Initiated: ____
     - Others (specify): ____
     - Secondary Ionization (Reference)
       - Attachment: ____
       - Detachment: ____
       - Ion-Ion Recombination: ____
       - Charge Transfer: ____
       - Dissociation/Recombination: ____
       - Others (specify): ____
       - Source of Rate Coefficients Used: ____
   - DISCHARGE POWER INPUT MODELED (√):
     - Uniform: ____ Non-Uniform: ____
     - E-Field: ____
     - Others (specify): ____
3. LASING KINETICS MODEL
   - GENERAL (specify):
     - Lasing Species: ____
     - Number of Species: ____
     - Number of Reactions: ____
     - Other Major Species Considered: ____
   - IMPACT EXCITATION MODELED (√): (Reference)
     - Vibrational: ____
     - Electronic: ____
     - Others (specify): ____
   - ENERGY TRANSFER MODES MODELED (√): (Reference)
     - V-T: ____
     - V-R: ____
     - V-V: ____
     - Others (specify): ____
     - Lasing Transition: P-Branch: ____ R-Branch: ____
     - Single Line Model (√): ____
     - Multi-Line Model (√): ____
       - Assumed Rotational Population Distribution State (√):
         - Equilibrium: ____
         - Nonequilibrium: ____
       - Number of Laser Lines Modeled: ____
     - Source of Rate Coefficients Used in Code: ____
   - LINE PROFILE MODELS (√):
     - Doppler Broadening: ____
     - Collisional Broadening: ____
     - Others (specify): ____
4. RECIRCULATION CONTAMINANTS MODELED (√):
   - O_x: ____ OH_x: ____
   - NO_x: ____ HNO_x: ____
   - Others (specify): ____
   - REFERENCE FOR REACTION MECHANISM AND RATES: ____
   - OTHER UNIQUE FEATURES: ____

CODE NAME: ELECT TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED: Laser cavity; electrical excitation

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To provide an analysis of electron kinetics for an arbitrary gas mixture (possibly including excited species) as a function of electric field by numerical solution of the Boltzmann equation.

ASSESSMENT OF CAPABILITIES: Code provides for electron-molecule, momentum transfer, superelastic, and electron-electron collisions; quasisteady state approximation retains dn_e/dt term for electron creation or loss from external ionization, secondary ionization, attachment, recombination, etc.

ASSESSMENT OF LIMITATIONS: No significant limitations.

OTHER UNIQUE FEATURES: Code is more general than most, inasmuch as there are few limitations on scattering processes, electron-electron collisions are included, superelastic collisions are included, and the analysis can be generated for an arbitrary number of species or reacitons. User-oriented, flexible input/output characteristics.

ORIGINATOR/KEY CONTACT:

Name: William B. Lacina

Organization: Northrop Research and Technology Center

Address: One Research Park, Palos Verdes Peninsula, CA 90274

Phone: (213) 377-4811 Ext. 362

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

"Theoretical Modeling of Molecular and Electron Kinetic Processes. Vol. I: Theoretical Formulation of Analysis and Description of Computer Programs. Vol. II: Fortran Computer Program Listings, " Northrop Rept. #NRTC-79-7R, January 1979 (T,U,L)

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s):

Ownership?: Northrop Research & Tech./William B. Lacina

Proprietary?: No. Public Domain

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions: yes (word size)

SELF-CONTAINED?: yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: 4,000

COMMENTS:

NOTE: The actual Boltzmann subroutines (without the main program ELECT and miscellaneous I/O routines) are shorter, and could be easily extracted from this code for usage elsewhere.

KINETICS CODE

CODE NAME: ELECT

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ____ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ____ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ____

KINETICS MODELED: Pulsed: ____ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ____

Implicit: ____

Others (specify): ____

REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Arbitrary

Number of Negative Species: "

Number of Neutral Species: "

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:	✓	
UV-Initiated:	✓	
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:	✓	
Charge Transfer:	✓	
Dissociation/ Recombination:	✓	
Others (specify):		

Source of Rate Coefficients Used: Miscellaneous

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ✓

Others (specify): E-beam or other

3. LASING KINETICS MODEL

GENERAL (specify): N.A.

Lasing Species: ____

Number of Species: ____

Number of Reactions: ____

Other Major Species Considered: ____

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:		
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:		
V-R:		
V-V:		
Others (specify):		

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ____

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ____

Number of Laser Lines Modeled: ____

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: ELENDIF TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED:

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Time Dependent Boltzmann Code

ASSESSMENT OF CAPABILITIES: (1) Backward prolongation (using a multi-step, variable stepsize integration algorithm); (2) Matrix solution of the steady-state Boltzmann equation including superelastic processes; (3) Time dependent relaxation calculation of the distribution function.

ASSESSMENT OF LIMITATIONS:

OTHER UNIQUE FEATURES: In addition to computing the electron energy distribution function, the code computes mean electron energy, drift velocity, characteristic energy, inelastic and superelastic rate coefficients, and energy flow rates for the processes being included in the calculation.

ORIGINATOR/KEY CONTACT:

Name: CPT Gary L. Duke

Organization: AFWAL/POOC-3

Address: Wright-Patterson AFB, Dayton, OH

Phone: (513) 255-2923

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T.U.L.: "ELENDIF": A Computer Program That Solves the Boltzmann Equation for a Partially Ionized Gas", JILA Information Center Report #19 by William L. Morgan, June 1979.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?:

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed):

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: Programmed in Fortran IV

SELF-CONTAINED?:

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	120K	15 Sec
Large Job:		

Approximate Number of FORTRAN Lines: 1200

COMMENTS:

NOTE: ELENDIF was brought to us by MAJ R.D. Franklin from Lawrence Lab. He has since moved on and ~~although~~ the code is operational it is not currently being used.

CODE NAME: ETRANV TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED:

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Time dependent solution of master equation for vibrational energy exchange. Used in modeling of vibrational-rotational laser systems (CO_2, CO, HF, DF).

ASSESSMENT OF CAPABILITIES: Time dependent or steady state solutions of state populations (200), with capability to treat five (5) different molecular species. Capable of being linked to solution of collisional Boltzmann equation

ASSESSMENT OF LIMITATIONS: Uncertainty in rate (V-V and V-T) scaling with respect to vibrational state and translational temperature.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: Wm. F. Bailey

Organization: AFIT/ENP A.F. Institute of Technology, Physics Dept.

Address: Bldg. 640, Area B, Wright-Patterson AFB, Ohio 45433

Phone: 513-255-2012

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

"Collision Induced Dissociation of Diatomic Molecules", AFAPL-TR-78-105, Nov. 1978 (RP)

STATUS:

Operational Currently?: X

Under Modification?:

Purpose(s):

Ownership?: U.S.A.F.

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: X

Machine Dependent Restrictions:

SELF-CONTAINED?: X

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

KINETICS CODE

CODE NAME: ETRANV

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: ______ 2-D: ______

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ______

Flow Direction: ______

KINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓

Implicit: ______

Others (specify): ______

REFERENCE OF METHOD USED: ______

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ______

Number of Negative Species: ______

Number of Neutral Species: ______

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:	✓	
UV-Initiated:		

Others (specify): ______

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/Recombination:	✓	

Others (specify): ______

Source of Rate Coefficients Used: ______

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ______

E-Field: ______

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: ______ }
Number of Species: ______ } variable
Number of Reactions: ______ }

Other Major Species Considered: ______

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	
Electronic:		

Others (specify): ______

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:		
V-V:	✓	

Others (specify): ______

Lasing Transition: P-Branch: ✓

R-Branch: ✓

Single Line Model (√): ✓

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ______

Number of Laser Lines Modeled: variable

Source of Rate Coefficients Used in Code: SSH

LINE PROFILE MODELS (√):

Doppler Broadening: ______

Collisional Broadening: ✓

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

CODE NAME: FREESL TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Cavity-Beam Duct Interface

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Compute development of free shear layer at interface of primary cavity flow and secondary injected beam duct flow, in a confined channel.

ASSESSMENT OF CAPABILITIES: Determines penetration of beam duct gas into cavity - diffusion of CO_2 into beam duct - velocity and species concentration profiles across shear layer and optical path difference.

ASSESSMENT OF LIMITATIONS: Determination of streamwise velocity at lower boundary requires solution of elliptic problem and is unknown within the context of the parabolic shear layer equations -- both zero shear and zero velocity boundary conditions used to bound problem.

OTHER UNIQUE FEATURES: Shear layer edge conditions determined through influence of shear layer displacement thickness on inviscid cavity flow. Unequal diffusion coefficients used in conjunction with binary diffusion approximation.

ORIGINATOR/KEY CONTACT:

Name: Peter Crowell

Organization: RDA

Address: ATO 9377 Int. Airport, Albuquerque, NM 87119

Phone: 505-844-3013

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T,L , RDA Report No. 80-A/K-21-0.1143

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Improved turbulence model (2 eq. model) current version uses eddy viscosity model.

Ownership?: RDA

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		500-600 sec on cray using 150 mesh
Large Job:		points and 200 marching steps

Approximate Number of FORTRAN Lines:

COMMENTS:

GAS DYNAMICS CODE

CODE NAME: FREESL

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ____ Expanding: √

FLUID GRID DIMENSIONALITY (√):

1-D: ____

2-D: √

3-D: ____

Time Dependent: ____

FLOW FIELD MODELED (√):

Compressible Flow: √

Incompressible: ____

Viscous Flow: √

No Flow: ____

BASIC MODELING APPROACH (√):

Algebraic: ____ Integral Method: ____

Finite Difference: √

Others (specify): ____

REFERENCE FOR APPROACH USED: Thin Shear Layer equations

2. GAS DYNAMICS MODEL FEATURES:

GAS SUPPLY MODELED (√):

Mixture Preparation: N_2-CO_2-He

Mixture Injection: N_2

Nozzles: ____

Flow Plates: ____

Others (specify): Beam duct injection into cavity is N_2

CAVITY INITIAL CONDITION DETERMINED BY (specify): assumed initial profiles

3. EXHAUST/RECIRCULATION MODEL

GENERAL SYSTEM MODELED (√):

Open System: ____ Closed System: ____

Closed Cycle: ____

EXHAUST SYSTEM FEATURES (√):

Pressure Recovery: ____

Ejector System: ____

Compressor/Fan: ____

Heat Exchanger: ____

Gas Make-Up: ____

Others (specify): ____

DECONTAMINATION METHOD TREATED (√):

Scrubber: ____

Shower: ____

Catalytic Reactor: none

Others (specify): ____

4. ACOUSTIC ATTENUATION MODEL

GENERAL FEATURES MODELED (√):

Single Pulse: ____ Repetitive Pulse: ____

DIMENSIONALITY TREATED (√):

1-D: ____ 2-D: ____ 3-D: ____

Time-Dependent: ____

DISTURBANCE MODELED (√):

Pressure Wave: ____ Entropy Wave: ____

Others (specify): ____

WAVE PROPAGATION TREATMENT (√):

Linear Wave: ____

Nonlinear Wave: ____

Others (specify): ____

THEORETICAL BASIS: (Reference) ____

NUMERICAL METHODOLOGY: (Reference) ____

ACOUSTIC ATTENUATORS CONSIDERED (√):

Muffler: ____ Heat Exchanger: ____

Horn: ____ Porous Wall: ____

Others (specify): ____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):

Index of Refraction Variation?: yes

Other (specify): Optical path difference computed across shear layer

OTHER UNIQUE FEATURES: ____

CODE NAME: GALERK TECHNICAL AREA(S): Electron Kinetics

DEVICE COMPONENTS TREATED:

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To predict electron transport and excitation-ionization coefficients from cross-section data.

ASSESSMENT OF CAPABILITIES: For the first time provides practical means of taking into account properly the effects of large inelastic cross-sections, such as that for vibrational excitation of N_2 or CO.

ASSESSMENT OF LIMITATIONS: Requires large computer, e.g., used only on CRAY I so far; requires user to adjust grid and to iterate solutions in presence of ionization.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: L. C. Pitchford (originator)

Organization: to 11/28/80 J.I.L.A. After 1/1/81-Sandia Laboratories

Address: U. of Colorado, Boulder, CO 80309 Albuquerque, NM

Phone: (303) 492-8255

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

L, RP - L.C. Pitchford, S.V. O'Neil, V.R. Rumble, Jr., Phys. Rev. A (in press) 1980.

STATUS:

Operational Currently?: X

Under Modification?: X

Purpose(s): To allow operation on CDC 7600 using external memory.

Ownership?: Joint Institute of Laboratory Astrophysics under support from AFAPL.

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CRAY I

TRANSPORTABLE?: to other CRAY I's

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		5 sec. on CRAY I
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

KINETICS CODE

CODE NAME: GALERK

1. CODE STRUCTURE
   COORDINATE SYSTEM (√): NA
   Cartesian: ______ Expanding: ______
   KINETICS GRID DIMENSIONALITY (√):
   1-D: ______ 2-D: √
   3-D: ______
   GAIN REGION SYMMETRY RESTRICTIONS:
   Gain Vary Along Optical Axis: ______
   Flow Direction: ______
   KINETICS MODELED: Pulsed: ______ CW: √
   NUMERICAL SCHEME USED IN RATE CALCULATION (√):
   Explicit: ______
   Implicit: ______
   Others (specify): Matrix inversion

   REFERENCE OF METHOD USED: Pitchford et al Phys. Rev. A (in press) 1980

2. PLASMA KINETICS MODEL
   NUMBER OF SPECIES TREATED (specify):
   Number of Positive Species: 0
   Number of Negative Species: 1 electrons
   Number of Neutral Species: ≤ 3
   REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:	√	
UV-Initiated:		
Others (specify):		

Secondary Ionization		(Reference)
Attachment:		
Detachment:		
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/ Recombination:		

   Others (specify): Collisional Ionization
   Source of Rate Coefficients Used: Crossections from Phelps (unpublished)
   DISCHARGE POWER INPUT MODELED (√):
   Uniform: √ Non-Uniform: ______
   E-Field: √
   Others (specify): ______

3. LASING KINETICS MODEL
   GENERAL (specify):
   Lasing Species: ______
   Number of Species: 1 electrons
   Number of Reactions: ______
   Other Major Species Considered: ______

   IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:		
Others (specify):	Rotation	

   ENERGY TRANSFER MODES MODELED (√): NA

		(Reference)
V-T:		
V-R:		
V-V:		

   Others (specify): ______
   Lasing Transition: P-Branch: ______
   R-Branch: ______
   Single Line Model (√): ______
   Multi-Line Model (√): ______
   Assumed Rotational Population Distribution State (√):
   Equilibrium: ______
   Nonequilibrium: ______
   Number of Laser Lines Modeled: ______
   Source of Rate Coefficients Used in Code: ______

   LINE PROFILE MODELS (√): NA
   Doppler Broadening: ______
   Collisional Broadening: ______
   Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): NA
   O_x: ______ OH_x: ______
   NO_x: ______ HNO_x: ______
   Others (specify): ______

   REFERENCE FOR REACTION MECHANISM AND RATES: ______

   OTHER UNIQUE FEATURES: ______

CODE NAME: HGX80 TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: laser/discharge cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Computation of laser/discharge properties in electrically excited rare-gas halide and mercury-halide lasers.

ASSESSMENT OF CAPABILITIES: Capable of quantitative calculation of excited state and ion densities and electric discharge properties.

ASSESSMENT OF LIMITATIONS: Restricted to spatially uniform, volume dominated media.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: William L. Nighan

Organization: United Technologies Research Center MS 90

Address: East Hartford, CT 06108

Phone: (203) 727-7596

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): L, RP

STATUS:

Operational Currently?: X

Under Modification?:

Purpose(s):

Ownership?: UTRC

Proprietary?: yes

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1100/81A

TRANSPORTABLE?: yes, FORTRAN

Machine Dependent Restrictions: none

SELF-CONTAINED?: no *

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	55K	approximately 10 sec
Large Job:		

Approximate Number of FORTRAN Lines: 1800

COMMENTS: * HGX80 requires Runge-Kutta routine from Sperry's MATHPACK, UTRC interpolation routines (TEBAR, SPLEVL and SPLINE), and UTRC code FU79 for the compitation of electron distribution functions and electron rate coefficients.

KINETICS CODE

CODE NAME: HGX80

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: √ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: √ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ____

KINETICS MODELED: Pulsed: √ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ____

Implicit: √

Others (specify): ____

REFERENCE OF METHOD USED: Modified Runge-Kutta S. Gill, Proc. Cambridge Philos. Soc. Vol 47, pp 96-108 (1951).

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 6

Number of Negative Species: 2

Number of Neutral Species: 9

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	√	
Self-Sustained:	√	
UV-Initiated:		
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	√	
Detachment:	√	
Ion-Ion Recombination:	√	
Charge Transfer:	√	
Dissociation/ Recombination:	√	
Others (specify):		

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: √ Non-Uniform: ____

E-Field: √

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: rare gas/mercury halide

Number of Species: ____

Number of Reactions: ____

Other Major Species Considered: ____

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:	√	
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:		
V-R:		
V-V:		

Others (specify): ____

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ____

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ____

Number of Laser Lines Modeled: ____

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√) none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: ILLOPT TECHNICAL AREA(S): Optics

DEVICE COMPONENTS TREATED: Optical Systems

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE:
Illumination evaluation and optimization.

ASSESSMENT OF CAPABILITIES:
Evaluates intensity patterns of very general optical systems.

ASSESSMENT OF LIMITATIONS:
Geometrical optics only, ray-tracing. no diffraction.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: Johanna Schruben

Organization: Westinghouse R&D Center

Address: Pittsburgh, PA 15235

Phone: 412-256-3611

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: T. P. Vogl, et al., "Semiautomatic design of illuminating systems", Applied Optics 11 (1972) 1087-1090.

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: Westinghouse

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed):
UNIVAC 1108

TRANSPORTABLE?: no

Machine Dependent Restrictions: yes

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600) (UNIVAC)
Small Job:	90,000K	60
Typical Job:		120
Large Job:		3600

Approximate Number of FORTRAN Lines:

COMMENTS:

OPTICS CODE

CODE NAME: ILLOPT

1. CODE STRUCTURE

BASIC TYPE (√):

- Physical Optics: ______
- Geometrical: ✓
  - Constant Gain: ______ Floating Gain: ______

FIELD (POLARIZATION) REPRESENTATION (√):

- Scalar: ✓
- Vector: ______

COORDINATE SYSTEM (√):

- Cartesian: ✓
- Expanding (specify): ______

TRANSVERSE GRID DIMENSIONALITY (specify):

- One-Dimensional: ______
- Two-Dimensional: ✓

FIELD SYMMETRY RESTRICTIONS?: ______

MIRROR SHAPE(S) ALLOWED (√):

- Square: ______
- Rectangular: ______
- Circular: ______
- Elliptical: ______
- Strip: ______
- Arbitrary: ✓

CONFIGURATION FLEXIBILITY (√):

- Fixed, Single Resonator Geometry: ______
- Fixed, Multiple Resonator Geometries: ______
- Modular, Multiple Resonator Geometries: ______
- Others (describe): Arbitrary

2. PROPAGATION TECHNIQUE (√ all that apply):

- Fresnel Integral Algorithms: ______
  - With Kernel Averaging: ______
  - Gaussian Quadrature: ______
  - Fast Fourier Transform (FFT): ______
  - Fast Hankel Transform (FHT): ______
  - Gardener-Fresnel-Kirchhoff (GFK): ______
  - Others (specify): Ray Trace
- Finite Difference Algorithms
  - Method (specify): ______

CONVERGENCE (√):

- Technique:
  - Power Comparison: ______
  - Field Comparison: ______
  - Others (specify): ______
- Acceleration Algorithms Used?: ______
  - Technique: ______

MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS (√):

- Prony: ______
- Others (specify): ______

3. RESONATOR MODELING FEATURES

GENERAL CAPABILITIES:

- Stability (√):
  - Stable Resonators: ______
  - Unstable Resonators: ______
- Type (√)
  - Standing Wave: ______
  - Traveling Wave (Ring): ______
  - Reverse Traveling Wave: ______
- Branch (√):
  - Positive: ______
  - Negative: ______
- Optical Element Models Included (√):
  - Flat Mirrors: ______
  - Spherical Mirrors: ______
  - Cylindrical Mirrors: ______
  - Telescopes: ______
  - Scraper Mirrors: ______
  - Deformable Mirrors: ______
  - Spatial Filters: ______
  - Gratings (specify type): ______
  - Other Elements (specify): ______

PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List): ______

(Continued)

OPTICS CODE
(Concluded)

CODE NAME: ILLOPT

GAIN MODELS (√):

- Bare Cavity Only: ______
- Simple Saturated Gain: ______
- Detailed Model (See Section 3 in Kinetics Code) ______

BARE CAVITY FIELD MODIFIER MODELS (√):

- Mirror Tilt: ✓
- Mirror Decentration: ✓
- Aberrations/Thermal Distortion:
  - Arbitrary: ______
  - Selected (specify): ______
- Reflectivity Loss: ✓
- Output Coupler Edges
  - Rolled: ______
  - Serrated: ______
  - Other: ______

LOADED CAVITY FIELD MODIFIER MODELS (√):

- Refractive Index Variation: ______
- Gas Absorption: ______
- Overlapped Beams (for flux updating): ______
  - Number of Overlaps Allowed: ______
- Others: ______

4. FAR FIELD MODELS (√):

- Beam Steering Removal: ______
- Optimal Focal Search: ______
- Beam Quality: ______
- Atmospheric Propagation Effects: ______
- Others: ______

BEAM CONTROL SYSTEM MODELED (√):

- Pointer/Tracker Subsystem: ______
- Beam Jitter: ______
- Autoalignment: ______
- Target Model:
  - Motion: ____ Effects: ____

OTHER UNIQUE FEATURES (e.g., Beam/Mode Rotation, Extra-Cavity Adaptive Optics, Multipath/Parasitic Effect, Beam Director Elements, etc.):

______

CODE NAME: KINBOLTZ TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: NA

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Given a set of reactions and reaction rates, the code will compute the time-dependent population levels in upper and lower states. A Boltzmann code is used to compute the reaction rates. Although it is set for Mercury-Xenon, it is constructed in a general fashion to allow for other elements.

ASSESSMENT OF CAPABILITIES: Very general and very modular. If the desired reactions are included, and cross-sections for the gases are available, the code will calculate the time-dependent population levels.

ASSESSMENT OF LIMITATIONS: NAMELIST is used for input, though this could be changed. It is fairly fast. For power out calculations, the user must supply the equations. The code is basically a linear diff. eqn. system solver.

OTHER UNIQUE FEATURES: Very modular. The Boltzmann code package and the integration package can be changed with a minimum of code changes. Input is checked for consistency and validity. Output is very clear.

ORIGINATOR/KEY CONTACT:

Name: Henry Happ

Organization: Tetra Corp.

Address: 1325 San Mateo, SE, Albuquerque, NM 87108

Phone: (505) 256-3595

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

Kinboltz: A Mercury-Xenon Kinetics Code (U)

Listings are available upon request.

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s):

Ownership?: U. S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600 or 176

TRANSPORTABLE?: Almost

Machine Dependent Restrictions: Formats are A8 or A10 for Hollerith Characters. NAMELIST is used.

SELF-CONTAINED?:

Other Codes Required (name, purpose): Runge-Kutta Integrator. Can be supplied with the package.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	45000	
Large Job:		

Approximate Number of FORTRAN Lines: 1000 Kinetics + 2400 Boltz = 3500 lines

COMMENTS:

12 K Kinetics Code + 32 K Boltz

KINETICS CODE

CODE NAME: KINBOLTZ

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: √ Expanding: ____
   - KINETICS GRID DIMENSIONALITY (√):
     - 1-D: √ 2-D: ____
     - 3-D: ____
   - GAIN REGION SYMMETRY RESTRICTIONS:
     - Gain Vary Along Optical Axis: ____
     - Flow Direction: ____
   - KINETICS MODELED: Pulsed: √ CW: ____
   - NUMERICAL SCHEME USED IN RATE CALCULATION (√):
     - Explicit: √
     - Implicit: ____
     - Others (specify): ____
   - REFERENCE OF METHOD USED: Thomson, Smith & Davies, "Boltz: A code...", Computer Phys. Comm., V.11, p. 369-383, 1976

2. PLASMA KINETICS MODEL
   - NUMBER OF SPECIES TREATED (specify):
     - Number of Positive Species: user-defined
     - Number of Negative Species: " "
     - Number of Neutral Species: " "
   - REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	√	User-defined
Self-Sustained:	√	" "
UV-Initiated:		
Others (specify):		

Secondary Ionization	(Reference)
Attachment:	User-defined
Detachment:	
Ion-Ion Recombination:	
Charge Transfer:	
Dissociation/Recombination:	
Others (specify):	

   - Source of Rate Coefficients Used: The user is responsible for providing the coefficients
   - DISCHARGE POWER INPUT MODELED (√):
     - Uniform: √ Non-Uniform: ____
     - E-Field: ____
     - Others (specify): ____

3. LASING KINETICS MODEL
   - GENERAL (specify):
     - Lasing Species: User-defined
     - Number of Species: user-defined
     - Number of Reactions: User-defined
     - Other Major Species Considered: ____
   - IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	√	user-defined
Electronic:	√	" "
Others (specify):		

   - ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	√	user-defined
V-R:	√	" "
V-V:	√	" "
Others (specify):		

   - Lasing Transition: P-Branch: ____
     - R-Branch: ____
   - Single Line Model (√): ____
   - Multi-Line Model (√): ____
     - Assumed Rotational Population Distribution State (√):
       - Equilibrium: ____
       - Nonequilibrium: ____
     - Number of Laser Lines Modeled: ____
   - Source of Rate Coefficients Used in Code: ____
   - LINE PROFILE MODELS (√):
     - Doppler Broadening: ____
     - Collisional Broadening: ____
     - Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√):
   - O_x: ____ OH_x: ____
   - NO_x: ____ HNO_x: ____
   - Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: KINETIC TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: None

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: This code is used for basic laser kinetics calculations for e-beam pumped lasers (it can treat discharge lasers also).

ASSESSMENT OF CAPABILITIES: It performs kinetics calculations using either a Maxwellian electron distribution (Te computed internally) or with an electron distribution computed by a subroutine that solves the Boltzmann equation. It will also perform amplifier calculations.

ASSESSMENT OF LIMITATIONS:

OTHER UNIQUE FEATURES: The code has very extensive graphics (some of which can be interactive) output

ORIGINATOR/KEY CONTACT:

Name: W. Lowell Morgan

Organization: Lawrence Livermore Laboratory

Address: Box 808, L-472, Livermore, CA 94505

Phone: (415) 422-6289

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): In general, none. I'll provide a listing

The Boltzmann solver is documented as JILA Information Center Report #19, Univ. of Colorado, Boulder, CO.

STATUS:

Operational Currently?: yes

Under Modification?: less so as time goes on

Purpose(s):

Ownership?:

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): CRAY 1A

TRANSPORTABLE?: perhaps

Machine Dependent Restrictions: core size and run time, as the code is optimized for vector calculations on the CRAY

SELF-CONTAINED?:

Other Codes Required (name, purpose): MAXRATE - uses cross-section data to create a table of rates vs. electron temperature.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	120K decimal	14 sec CRAY $\simeq$ 30 sec 7600*
Large Job:	260K decimal	60 sec CRAY $\simeq$ 12 min 7600**

Approximate Number of FORTRAN Lines: 5500

COMMENTS: * The kinetics only takes a few seconds, the remainder is graphics (this is the Maxwellian version) ** This is the version that includes solution of the Boltzmann equation for electrons.

KINETICS CODE

CODE NAME: KINETIC

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: ____ Expanding: ____
   - KINETICS GRID DIMENSIONALITY (√):
     - 1-D: ✓ 2-D: ____
     - 3-D: ____
   - GAIN REGION SYMMETRY RESTRICTIONS:
     - Gain Vary Along Optical Axis: ____
     - Flow Direction: ____
   - KINETICS MODELED: Pulsed: ✓ CW: ____
   - NUMERICAL SCHEME USED IN RATE CALCULATION (√):
     - Explicit: ____
     - Implicit: ✓
     - Others (specify): ____
   - REFERENCE OF METHOD USED: Gear

2. PLASMA KINETICS MODEL
   - NUMBER OF SPECIES TREATED (specify):
     - Number of Positive Species: Arbitrary
     - Number of Negative Species: "
     - Number of Neutral Species: 10
   - REACTION MECHANISM MODELED (√):
     - Primary Ionization: (Reference)
       - E-Beam: ✓
       - Self-Sustained: ✓
       - UV-Initiated: ✓
     - Others (specify): fission fragments
     - Secondary Ionization (Reference)
       - Attachment: ✓
       - Detachment: ✓
       - Ion-Ion Recombination: ✓
       - Charge Transfer: ✓
       - Dissociation/Recombination: ✓
       - Others (specify): ____
     - Source of Rate Coefficients Used: cross sections
   - DISCHARGE POWER INPUT MODELED (√):
     - Uniform: ✓ Non-Uniform: ✓
     - E-Field: ✓
     - Others (specify): ____

3. LASING KINETICS MODEL
   - GENERAL (specify): we have studied Xe_2^*, KrF, ArF, XeF, Xe Cl
     - Lasing Species: anything:
     - Number of Species: 30
     - Number of Reactions: 100
     - Other Major Species Considered: ____
   - IMPACT EXCITATION MODELED (√): (Reference)
     - Vibrational: ✓
     - Electronic: ✓
     - Others (specify): ____
   - ENERGY TRANSFER MODES MODELED (√): (Reference)
     - V-T: ✓
     - V-R: ____
     - V-V: ✓
     - Others (specify): ____
     - Lasing Transition: P-Branch: ____
       - R-Branch: ____
     - Single Line Model (√): ✓
     - Multi-Line Model (√): ____
       - Assumed Rotational Population Distribution State (√):
         - Equilibrium: ✓
         - Nonequilibrium: ____
       - Number of Laser Lines Modeled: ____
     - Source of Rate Coefficients Used in Code: ____
   - LINE PROFILE MODELS (√):
     - Doppler Broadening: ____
     - Collisional Broadening: ____
     - Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none
   - O_x: ____ OH_x: ____
   - NO_x: ____ HNO_x: ____
   - Others (specify): ____
   - REFERENCE FOR REACTION MECHANISM AND RATES: ____
   - OTHER UNIQUE FEATURES: The code is very general, all information concerning specific problems is in the data set.

CODE NAME: KRF TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED:

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Modeling KRF lasers and amplifiers.

ASSESSMENT OF CAPABILITIES: Handles gas deposition, kinetics, absorption, lasing in Fabry-Perot cavity.

ASSESSMENT OF LIMITATIONS: Specific code for KRF

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: Jeanette Betts

Organization: TRW DSSG

Address: 1 Space Park, Redondo Beach, CA 90278

Phone: 213-536-1453

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

L

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s):

Ownership?: TRW

Proprietary?: yes-developed under IR&D

MACHINE/OPERATING SYSTEM (on which installed): CDC Cyber 174

TRANSPORTABLE?: yes

Machine Dependent Restrictions:

SELF-CONTAINED?: yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	FL-50500	42 sec Cyber 174
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

KINETICS CODE

CODE NAME: KRF

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: √ 2-D: ______

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: √

Flow Direction: ______

KINETICS MODELED: Pulsed: √ CW: ______

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ______

Implicit: ______

Others (specify): ______

REFERENCE OF METHOD USED: Modified Trainor

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 6

Number of Negative Species: 1

Number of Neutral Species: 17

REACTION MECHANISM MODELED (√):

Primary Ionization: (Reference)

E-Beam: √

Self-Sustained: ______

UV-Initiated: ______

Others (specify): ______

Secondary Ionization (Reference)

Attachment: ______

Detachment: ______

Ion-Ion Recombination: ______

Charge Transfer: ______

Dissociation/ Recombination: ______

Others (specify): ______

Source of Rate Coefficients Used: literature-several sources

DISCHARGE POWER INPUT MODELED (√):

Uniform: ______ Non-Uniform: ______

E-Field: ______

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: KrF

Number of Species: 24

Number of Reactions: 92

Other Major Species Considered: Ar^+, ArF, F^-, Ar^*, Kr^*, F_2

IMPACT EXCITATION MODELED (√):

(Reference)

Vibrational: ______

Electronic: √

Others (specify): ______

ENERGY TRANSFER MODES MODELED (√):

(Reference)

V-T: ______

V-R: ______

V-V: ______

Others (specify): ______

Lasing Transition: P-Branch: ______

R-Branch: ______

Single Line Model (√): ______

Multi-Line Model (√): ______

Assumed Rotational Population Distribution State (√):

Equilibrium: ______

Nonequilibrium: ______

Number of Laser Lines Modeled: ______

Source of Rate Coefficients Used in Code: ______

LINE PROFILE MODELS (√):

Doppler Broadening: ______

Collisional Broadening: ______

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√):

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

CODE NAME: LAGAD TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Laser Cavity & Flow Loop

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Compute non-steady gas dynamics resulting from discharge heating & flow loop heat exchanger & blower requirements.

ASSESSMENT OF CAPABILITIES: Fast running - computes initial conditions using shock tube theory & wave propagation by method of characteristics.

ASSESSMENT OF LIMITATIONS: Constant gas properties, i.e. Cp, Cv, γ

OTHER UNIQUE FEATURES: Calcomp Plot of Wave Diagram

ORIGINATOR/KEY CONTACT:

Name: Martin J. Pechersky

Organization: Westinghouse R&D Center

Address: 1310 Beulah Road, Pgh, PA 15235

Phone: 412-256-7353

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

Listing is proprietary, no other documentation

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Westinghouse

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC-1108

TRANSPORTABLE?: yes

Machine Dependent Restrictions:

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	22411	17 sec - UNIVAC-1108
Large Job:		

Approximate Number of FORTRAN Lines: 800

COMMENTS:

GAS DYNAMICS CODE

CODE NAME: LAGAD

1. CODE STRUCTURE
   COORDINATE SYSTEM (√):
   Cartesian: ✓ Expanding: ____
   FLUID GRID DIMENSIONALITY (√):
   1-D: ✓
   2-D: ____
   3-D: ____
   Time Dependent: ____
   FLOW FIELD MODELED (√):
   Compressible Flow: ✓
   Incompressible: ____
   Viscous Flow: ____
   No Flow: ____
   BASIC MODELING APPROACH (√):
   Algebraic: ✓ Integral Method: ____
   Finite Difference: ____
   Others (specify): Method of Charistics

   REFERENCE FOR APPROACH USED:
   Text's of Shapiro & Rudinger

2. GAS DYNAMICS MODEL FEATURES:
   GAS SUPPLY MODELED (√):
   Mixture Preparation: ____
   Mixture Injection: ____
   Nozzles: ____
   Flow Plates: ____
   Others (specify): ____

   CAVITY INITIAL CONDITION DETERMINED BY (specify): Code

3. EXHAUST/RECIRCULATION MODEL
   GENERAL SYSTEM MODELED (√):
   Open System: ____ Closed System: ____
   Closed Cycle: ✓
   EXHAUST SYSTEM FEATURES (√):
   Pressure Recovery: ____
   Ejector System: ____
   Compressor/Fan: ✓
   Heat Exchanger: ✓
   Gas Make-Up: ____
   Others (specify): ____

   DECONTAMINATION METHOD TREATED (√):
   Scrubber: ____
   Shower: ____
   Catalytic Reactor: ____
   Others (specify): ____

4. ACOUSTIC ATTENUATION MODEL
   GENERAL FEATURES MODELED (√):
   Single Pulse: ✓ Repetitive Pulse: ____
   DIMENSIONALITY TREATED (√):
   1-D: ✓ 2-D: ____ 3-D: ____
   Time-Dependent: ____
   DISTURBANCE MODELED (√):
   Pressure Wave: ✓ Entropy Wave: ____
   Others (specify): Hot gas clearing*

   WAVE PROPAGATION TREATMENT (√):
   Linear Wave: ____
   Nonlinear Wave: ✓
   Others (specify): ____

   THEORETICAL BASIS: (Reference) ____

   NUMERICAL METHODOLOGY: (Reference) ____

   ACOUSTIC ATTENUATORS CONSIDERED (√):
   Muffler: ____ Heat Exchanger: ____
   Horn: ____ Porous Wall: *
   Others (specify): ____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):
   Index of Refraction Variation?: ____
   Other (specify): ____

   OTHER UNIQUE FEATURES:
   *Auxillary code to compute in flow acoustic damping

CODE NAME: LASER TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: General laser kinetics synthesis and analysis. Coupled system of molecular kinetics, plasma kinetics, external discharge, circuit, and optical radiative extraction for a spatially homogeneous medium. Applicable to a broad class of transient, electrically excited laser systems. User-oriented, flexible input/output structure, well documented.

ASSESSMENT OF CAPABILITIES: This code synthesizes, from an arbitrary list of molecular kinetics reactions and species, a completely coupled laser kinetics analysis . Molecular kinetics subroutines for an arbitrary reaction scheme are translated automatically into FORTRAN source code and coupled to plasma kinetics, optical fields, etc.

ASSESSMENT OF LIMITATIONS: Applicable to transient analysis of electrically excited laser system. Developed in connection with rare gas halide excimer lasers (e.g. KrF). Capability is quite comprehensive and general.

OTHER UNIQUE FEATURES: Program automatically synthesizes its own molecular kinetics source code for execution. Secondary electron collisions are automatically linked to electron kinetics analysis provided by numerical solution of Boltzmann equation. Boltzmann analysis contains superelastic/electron-electron/inelastic/mom.transfer.

ORIGINATOR/KEY CONTACT:

Name: William B. Lacina

Organization: Northrop Research & Technology Center

Address: One Research Park, Palos Verdes Peninsula, CA 90274

Phone: (213) 377-4811 ext. 362

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): "Theoretical Modelling of Molecular and Electron Kinetic Processes, Vol. I: Theoretical Formulation of Analysis and Description of Computer Programs. *Vol. II: Fortran Computer Program Listings,* " Northrop Rept. #NRTC-79-7R, January 1979. (T,U,L)

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s): Modifications by other users may be in progress.

Ownership?: Northrop Research & Tech./William B. Lacina

Proprietary?: Public Domain

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions: Yes (CDC word size)

SELF-CONTAINED?: yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	200,000	
Large Job:		

Approximate Number of FORTRAN Lines: 6,000

COMMENTS:

KINETICS CODE

CODE NAME: LASER

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: NA Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: no

Flow Direction: ____

KINETICS MODELED: Pulsed: ✓ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓

Implicit: ✓

Others (specify): rate constants from input, and from Boltzmann plasma calculations.

REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: arb.

Number of Negative Species: arb.

Number of Neutral Species: arb.

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:	✓	
UV-Initiated:	✓	

Others (specify): reasonably arbitrary.

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:	✓	
Charge Transfer:	✓	
Dissociation/ Recombination:	✓	

Others (specify): ____

Source of Rate Coefficients Used: miscellaneous

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ✓

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: ONE

Number of Species: arbitrary

Number of Reactions: arbitrary

Other Major Species Considered: ____

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	
Electronic:	✓	
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:		
V-R:		
V-V:		

Others (specify): ____

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ____

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ____

Number of Laser Lines Modeled: ____

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: LASIM TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED:

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE:
Simulation of UV initiated, self-sustained discharge - pumped XeF lasers.

ASSESSMENT OF CAPABILITIES:
Predicts discharge & laser operation - physical description of experimental system is used. Circuit - discharge interaction is modeled.

ASSESSMENT OF LIMITATIONS:
Spatially uniform plasma/laser model.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: L.E. Kline

Organization: Westinghouse R&D

Address: 1310 Beulah Road, Pittsburgh, PA 15235

Phone: 412-256-7552

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

L, RP: "Formation, Quenching & Absorbition Processes in Self-Sustained Discharge Pumped XeF Laser" L.E. Kline, L.J. Denes, S. G. Leslie, and R.R. Mitchell. Proc. Int'l Conf.on Lasers 1978, Orlando, FL (RP)

STATUS:

Operational Currently?: Yes

Under Modification?:

Purpose(s):

Ownership?: Gov't contract

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC-1100

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): Boltzman Solver is required to calculate electron excitation rates vs. E/P

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	~10K	< 10 sec
Large Job:		

Approximate Number of FORTRAN Lines: 600

COMMENTS:

KINETICS CODE

CODE NAME: LASIM

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ____ 2-D: ____

3-D: ____ 0-D X

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: No

Flow Direction: No

KINETICS MODELED: Pulsed: ✓ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓

Implicit: ____

Others (specify): ____

REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 2

Number of Negative Species: 2

Number of Neutral Species: 5

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:	✓	
UV-Initiated:	✓	
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:		
Ion-Ion Recombination:	✓	
Charge Transfer:		
Dissociation/ Recombination:	✓	
Others (specify):		

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ____

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: 1

Number of Species: 9

Number of Reactions: 20

Other Major Species Considered: ____

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:	✓	
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:		
V-R:		
V-V:		

Others (specify): ____

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ✓

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ____

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): None

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: Kline et al., Proc Laser '78

OTHER UNIQUE FEATURES: ____

CODE NAME: MOC TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Computes the transient flow associated with sudden energy deposition that is characteristic of pulsed laser operation.

ASSESSMENT OF CAPABILITIES:

ASSESSMENT OF LIMITATIONS: Shock wave interaction with solid boundaries not modeled.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: C. C. Shih and G. R. Karr

Organization: Mech. Eng. Dept., Univ. of Ala. in Huntsville

Address: Huntsville, AL 35809

Phone: (205) 895-6330, (205) 895-6075

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): C. C. Shih, G. R. Karr, J. F. Perkins, Investigation of Transient Flow and Heating Problems Characteristics of High Energy Laser Gas Circulation Systems, UAH Research Report No. 219, March 1979.

STATUS:

Operational Currently?: X

Under Modification?: X

Purpose(s): Intend to look at wave interaction with acoustic attenuators

Ownership?: UAH

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1108

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none

SELF-CONTAINED?: yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		order of 100 sec.
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

GAS DYNAMICS CODE

CODE NAME: MOC

1. CODE STRUCTURE
   COORDINATE SYSTEM (√):
   - Cartesian: ✓ Expanding: ____
   FLUID GRID DIMENSIONALITY (√):
   - 1-D: ✓
   - 2-D: ____
   - 3-D: ____
   - Time Dependent: ✓
   FLOW FIELD MODELED (√):
   - Compressible Flow: ✓
   - Incompressible: ____
   - Viscous Flow: ✓
   - No Flow: ____
   BASIC MODELING APPROACH (√):
   - Algebraic: ✓ Integral Method: ____
   - Finite Difference: ✓
   - Others (specify): ____

   REFERENCE FOR APPROACH USED: Method of Characteristics

2. GAS DYNAMICS MODEL FEATURES:
   GAS SUPPLY MODELED (√):
   - Mixture Preparation: ✓
   - Mixture Injection: ____
     - Nozzles: ____
     - Flow Plates: ____
     - Others (specify): ____

   CAVITY INITIAL CONDITION DETERMINED BY (specify): given

3. EXHAUST RECIRCULATION MODEL
   GENERAL SYSTEM MODELED (√):
   - Open System: ✓ Closed System: ____
   - Closed Cycle: ____
   EXHAUST SYSTEM FEATURES (√):
   - Pressure Recovery: ✓
   - Ejector System: ____
   - Compressor Fan: ____
   - Heat Exchanger: ____
   - Gas Make-Up: ____
   - Others (specify): ____

DECONTAMINATION METHOD TREATED (√):
- Scrubber: ____
- Shower: ____
- Catalytic Reactor: ____
- Others (specify): ____

4. ACOUSTIC ATTENUATION MODEL
   GENERAL FEATURES MODELED (√):
   - Single Pulse: ✓ Repetitive Pulse: ____
   DIMENSIONALITY TREATED (√):
   - 1-D: ✓ 2-D: ____ 3-D: ____
   - Time-Dependent: ✓
   DISTURBANCE MODELED (√):
   - Pressure Wave: ✓ Entropy Wave: ✓
   - Others (specify): ____

   WAVE PROPAGATION TREATMENT (√):
   - Linear Wave: ✓
   - Nonlinear Wave: ✓
   - Others (specify): ____

   THEORETICAL BASIS: (Reference) Method of Characteristics

   NUMERICAL METHODOLOGY: (Reference) Finite Difference

   ACOUSTIC ATTENUATORS CONSIDERED (√):
   - Muffler: ____ Heat Exchanger: ____
   - Horn: ____ Porous Wall: ____
   - Others (specify): none

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):
   - Index of Refraction Variation?: ____
   - Other (specify): Fractional density gradient ($\Delta\rho/\rho$)

OTHER UNIQUE FEATURES: ____

CODE NAME: NRL Laser Kinetics Code (Unofficial) TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity; Chemical Kinetics electrical circuit; /electron kinetics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Modeling of a variety of high power gas lasers. Mostly rare gas halides. Some non-lasing applications such as modeling of absorption in pure rare gases and isotope separation kinetics.

ASSESSMENT OF CAPABILITIES: Highly flexible; Has been easily adapted to a wide variety of physical systems. Easily portable from one computer to another. No convergence problems with chemical kinetics integrator. Coupled external circuit.

ASSESSMENT OF LIMITATIONS: Spatially homogeneous (zero-dimensional) approximation for kinetics. E-beam ionization rate provided as external waveform. Secondary electron kinetics (time-dependent).

OTHER UNIQUE FEATURES: Reaction scheme specified using symbolic names for reactants and products. Output provides detailed and useful description of kinetics and lasing.

ORIGINATOR/KEY CONTACT:

Name: Louis J. Palumbo

Organization: Laser Physics Branch, Code 6540

Address: Naval Research Laboratory, Washington, DC 20375

Phone: (202) 767-2255

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

(T, RP): T. H. Johnson, L.J. Palumbo and A.M. Hunter, II, "Kinetics Simulation of High-Power Gas Lasers", IEEE J. Quant. Electron., Vol. QE-15, No. 5, pp. 289-301, (May 1979).

(L): Originator supplies listings and tape copies on request. (Listing is well commented) (SEE ATTACHED SHEET)

STATUS:

Operational Currently?: Yes (several versions)

Under Modification?: yes

Purpose(s): Modifications are underway to make code more user oriented and to make more efficient use of computer memory.

Ownership?: No (developed on U.S. Gov't time-available to public)

Proprietary?: No (earlier versions have been sent to private industrial labs

MACHINE/OPERATING SYSTEM (on which installed): Texas Instruments - Advanced Scientific Computer (ASC). Also was successfully adapted to IBM-370.

TRANSPORTABLE?: Resonably

Machine Dependent Restrictions: Some versions contain ENCODE/DECODE statements, these are currently being replaced. Code is more efficient on a vectorizing / Fortran compiler.

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	~90,000 32-bit words	60
Typical Job:	150,000 " " "	120
Large Job:	~250,000 " " "	600

Approximate Number of FORTRAN Lines: 6000

COMMENTS: Very simple time-dependent lasing computation for a Fabry-Perot cavity using constant gain, geometric optics.

AVAILABLE DOCUMENTATION con't: CODE NAME: NRL Laser Kinetics Code

(U, L): Being written - will be published as an NRL Memorandum Report by L. J. Palumbo (early 1981) (perhaps a series of memo reports).

(RP): Several papers involving interpretation of experimental results using a model published mostly in Appl. Phys. Lett. 1977-1980.

KINETICS CODE

CODE NAME: NRL LASER

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ____ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____ Spatially homogeneous (Zero-D)

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____ (sometimes)

Flow Direction: no flow

KINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓

Implicit: ____

Others (specify): Runge-Kutta-Treanor Method for stiff diff. eq.s

REFERENCE OF METHOD USED: C.E. Treanor Math. Compat. Vol. 20, p 39 (1966)

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0-15 typical

Number of Negative Species: 0-5 typical

Number of Neutral Species: 5-50 typical

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	external waveform for
Self-Sustained:	✓	/ionization rate
UV-Initiated:	✓	

Others (specify): E-beam sustained as well as pure e-beam pumpted.

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:	✓	
Charge Transfer:	✓	
Dissociation/ Recombination:	✓	

Others (specify): ____

Source of Rate Coefficients Used: mostly open literature

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ✓

Others (specify): external circuit coupled to kinetics.

Electron kinetics are modeled either by solving the steady state Boltzmann transport equation or by a time-dependent but greatly simplified rate-equation method.

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: ✓

Number of Species: 10-50 typical

Number of Reactions: 10-200 typical

Other Major Species Considered: ____

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	
Electronic:	✓	

Others (specify): ____

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:	✓	unusually small for
V-V:	✓	the systems modeled

Others (specify): ____

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ✓

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ____

Number of Laser Lines Modeled: 1 or 2

Source of Rate Coefficients Used in Code: mostly open literature

LINE PROFILE MODELS (√):

Doppler Broadening: none

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

CODE NAME: OPTEX TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The lasing outputs for the 10 μm P(14) and P(18) lines are predicted as a function of the individual cavity lengths for a pulsed TEA laser

ASSESSMENT OF CAPABILITIES: The ratio of energies contained in the two transitions was verified experimentally.

ASSESSMENT OF LIMITATIONS: The predicted pulse shapes are questionable.

OTHER UNIQUE FEATURES: A Gaussian mode pattern was used instead of a plane wave.

ORIGINATOR/KEY CONTACT:

Name: Dennis Suhre

Organization: Westinghouse Research

Address: 1310 Beulah Road, Pittsburgh, PA 15235

Phone: 412-256-7353

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

T: D.R. Suhre, "Analysis of a Multiple Wavelength CO_2 Laser," Westinghouse Report 80-1C2-OPTEX-P1, May 1980.

STATUS:

Operational Currently?: No

Under Modification?: No

Purpose(s):

Ownership?: Westinghouse

Proprietary?: Yes

MACHINE/OPERATING SYSTEM (on which installed): UNIVAC 1100

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): None

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600) (UNIVAC 1100)
Small Job:		5
Typical Job:		10
Large Job:	resonable	20

Approximate Number of FORTRAN Lines: 150

COMMENTS:

KINETICS CODE

CODE NAME: OPTEX

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ✓

KINETICS GRID DIMENSIONALITY (√):

1-D: ______ 2-D: ✓

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ______

Flow Direction: ______

KINETICS MODELED: Pulsed: ✓ CW: ______

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓

Implicit: ______

Others (specify): ______

REFERENCE OF METHOD USED: IEEE J. Quant. Electron. QE-9, 139 (1973)

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 0

Number of Negative Species: 0

Number of Neutral Species: 3

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:		
UV-Initiated:		

Others (specify): ______

Secondary Ionization		(Reference)
Attachment:		
Detachment:		
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/Recombination:		

Others (specify): ______

Source of Rate Coefficients Used: ______

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ______

E-Field: ______

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: 3 (CO_2, N_2, He)

Number of Reactions: ______

Other Major Species Considered: ______

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	Sov. J. Quantum Electron. 4, 843 (197
Electronic:		
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	IEEE J. Quant. Electron. QE-9, 139 (1973)
V-R:		
V-V:	✓	IEEE J. Quant. Electron. QE-9, 139 (1973)

Others (specify): ______

Lasing Transition: P-Branch: ✓

R-Branch: ______

Single Line Model (√): ______

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ______

Number of Laser Lines Modeled: 2

Source of Rate Coefficients Used in Code: Rev. Mod. Phys. 41, 26 (1969)

LINE PROFILE MODELS (√):

Doppler Broadening: ______

Collisional Broadening: ✓

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): None

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

CODE NAME: POSEIDON* TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Laser Cavity; Acoustic Attenuation Subsystem

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: The code is used to model one-dimensional flow and acoustics in the laser cavity and the acoustic attenuation subsystem. This is used to predict recovery time of the medium within the laser cavity to a specified homegeneity. A two-dimensional version also exists.

ASSESSMENT OF CAPABILITIES: The code has demonstrated stable and accurate numerical solutions to unsteady flow problems characterized by both strong shock waves and weak acoustic level waves with extremely small numerical diffusion (no artifical viscosity is required).

ASSESSMENT OF LIMITATIONS: Boundary layer phenomena are not simulated and two-dimensional version has high noise floor.

OTHER UNIQUE FEATURES: Any type of gas at any temperature may be employed. Any number of repetitive pulses may be specified. System geometry may be altered at will. The code incoporates: compressibility, nonlinearity, heat transfer, bulk resistance, and mass transport through the side walls. Reflections off of /a sudden expansion downstream of the laser cavity incorporate /two-dimensional gas dynamics to account for the shape of the /openin

ORIGINATOR/KEY CONTACT:

Name: James H. Morris

Organization: Poseidon Research

Address: 9550 Owensmouth Avenue, Chatsworth, CA 91311

Phone: (213) 341-9172

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T = Poseidon Research Reports: #8, #16, #21, #22, #32

RP = Boris, J.P. and Book, D. L. 1971 Flux Corrected Transport.

I. Shasta, A Fluid Transport Algorithm That Works.

Journal of Computational Physics 11, pp. 38-69 (1973)

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s):

Ownership?: Poseidon Research

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY I

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?: Yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	200,000	20 sec., CRAY I
Large Job:		

Approximate Number of FORTRAN Lines: 2000

COMMENTS: *Name generated for identification purposes.

GAS DYNAMICS CODE

CODE NAME: POSEIDON

1. CODE STRUCTURE
   COORDINATE SYSTEM (✓):
   Cartesian: ✓ Expanding: ____
   FLUID GRID DIMENSIONALITY (✓):
   1-D: ✓
   2-D: ✓
   3-D: ____
   Time Dependent: ✓
   FLOW FIELD MODELED (✓):
   Compressible Flow: ✓
   Incompressible: ____
   Viscous Flow: ____
   No Flow: ____
   BASIC MODELING APPROACH (✓):
   Algebraic: ____ Integral Method: ____
   Finite Difference: ✓
   Others (specify): ____

   REFERENCE FOR APPROACH USED:
   SHASTA Algorithm
   Boris & Book, J. Comp. Physiccs II, 38-69

2. GAS DYNAMICS MODEL FEATURES:
   GAS SUPPLY MODELED (✓):
   Mixture Preparation: ____
   Mixture Injection: ✓
   Nozzles: ____
   Flow Plates: ✓
   Others (specify): ____

   CAVITY INITIAL CONDITION DETERMINED BY (specify): S.S. Isentropic flow relations and initial over-temperature distribution

3. EXHAUST/RECIRCULATION MODEL
   GENERAL SYSTEM MODELED (✓):
   Open System: ✓ Closed System: ____
   Closed Cycle: ____
   EXHAUST SYSTEM FEATURES (✓):
   Pressure Recovery: ____
   Ejector System: ____
   Compressor/Fan: ____
   Heat Exchanger: ____
   Gas Make-Up: ____
   Others (specify):
   1D: Sudden expansion boundary condition
   2D: Open

DECONTAMINATION METHOD TREATED (✓):
Scrubber: ____
Shower: ____
Catalytic Reactor: ____
Others (specify): None

4. ACOUSTIC ATTENUATION MODEL
   GENERAL FEATURES MODELED (✓):
   Single Pulse: ✓ Repetitive Pulse: ✓
   DIMENSIONALITY TREATED (✓):
   1-D: ✓ 2-D: ✓ 3-D: ____
   Time-Dependent: ____
   DISTURBANCE MODELED (✓):
   Pressure Wave: ✓ Entropy Wave: ✓
   Others (specify): ____

   WAVE PROPAGATION TREATMENT (✓):
   Linear Wave: ____
   Nonlinear Wave: ✓
   Others (specify): ____

   THEORETICAL BASIS: (Reference)
   Poseidon Research Report No. 16

   NUMERICAL METHODOLOGY: (Reference) ____

   ACOUSTIC ATTENUATORS CONSIDERED (✓):
   Muffler: ✓ Heat Exchanger: ✓
   Horn: ✓ Porous Wall: ✓
   Others (specify): ____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (✓):
   Index of Refraction Variation?: ✓
   Other (specify): ____

OTHER UNIQUE FEATURES: ____

CODE NAME: PSI LASER * TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: A series of codes for general kinetic calculations, D_2/HCl, Kr_2. Xe_2, Xe_2, KrF, CO etc. Calculate cavity gain and powerout for a Fabry-Perot Resonator

ASSESSMENT OF CAPABILITIES: One-dimensional in time, and one-dimensional in space.

ASSESSMENT OF LIMITATIONS:

OTHER UNIQUE FEATURES: Fluid Dynamics can be modeled separately. Has been used for GDL and Chemical lasers. Output can be used for amplification calculations.

ORIGINATOR/KEY CONTACT:

Name: Paul Lewis or Ray L. Taylor

Organization: Physical Sciences, Inc. Research and Laser Technology, Ir

Address: 30 Commerce Way, Woburn, MA 01801 6 Frank St., Rockport, MA 01966

Phone: (617) 933-8500 (617) 546-7798

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

RP: PSI TR 19

PSI TR 182

STATUS:

Operational Currently?: X

Under Modification?:

Purpose(s):

Ownership?: PSI, RLT

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): Prime 400 easily adaptable to IBM, CDC

TRANSPORTABLE?:

Machine Dependent Restrictions: none known

SELF-CONTAINED?:

Other Codes Required (name, purpose): Boltzmann Code. E-Beam source code

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:	60K	
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: 1750

COMMENTS:

* Name generated for identification purpose.

KINETICS CODE

CODE NAME: PSI LASER

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ___

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ___

3-D: ___

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ___

Flow Direction: ✓

KINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ___

Implicit: ✓

Others (specify): ___

REFERENCE OF METHOD USED: ___

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ___

Number of Negative Species: ___

Number of Neutral Species: ___

REACTION MECHANISM MODELED (√):

Primary Ionization: (Reference)

E-Beam: ✓

Self-Sustained: ✓

UV-Initiated: ___

Others (specify): ___

Secondary Ionization (Reference)

Attachment: ✓

Detachment: ✓

Ion-Ion Recombination: ✓

Charge Transfer: ✓

Dissociation/ Recombination: ✓

Others (specify):

Penning Ionization

Source of Rate Coefficients Used:

Literature

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ✓ ✓(time only)

E-Field: ✓

Others (specify): ___

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: Arbitrary

Number of Species: Arbitrary, typically<

Number of Reactions: Arbitrary

Other Major Species Considered: Impurities discharge lasers.

IMPACT EXCITATION MODELED (√):

(Reference)

Vibrational: ✓

Electronic: ✓

Others (specify):

Rotational

ENERGY TRANSFER MODES MODELED (√):

(Reference)

V-T: ✓

V-R: ___

V-V: ✓

Others (specify): ___

Lasing Transition: P-Branch: ✓

R-Branch: ___

Single Line Model (√): ✓

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ___

Number of Laser Lines Modeled: Arbitrary

Source of Rate Coefficients Used in Code:

Literature

TR-182

LINE PROFILE MODELS (√):

Doppler Broadening: ✓

Collisional Broadening: ✓

Others (specify):

Voigt

4. RECIRCULATION CONTAMINANTS MODELED (√): none

x: ___ OH_x: ___

NO_x: ___ HNO_x: ___

Others (specify): ___

REFERENCE FOR REACTION MECHANISM AND RATES: ___

OTHER UNIQUE FEATURES: ___

CODE NAME: REDAC TECHNICAL AREA(S):

DEVICE COMPONENTS TREATED: Pulsed Electrical Power

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: model PFN's performance. This is a general purpose circuit analysis code.

ASSESSMENT OF CAPABILITIES: excellent

ASSESSMENT OF LIMITATIONS: as good as input

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: E. Wheatley

Organization: Rocketdyne Division of Rockwell, M.S. FA-28

Address: 6633 Canoga Ave., Canoga Pk 91304

Phone: 213-709-7136

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

U: "REDAC User's Manual". Rockwell Internal Document, S77-749/501, Aug. 78.

STATUS:

Operational Currently?: X

Under Modification?:

Purpose(s):

Ownership?: Rockwell

Proprietary?: yes

MACHINE/OPERATING SYSTEM (on which installed): CDC

TRANSPORTABLE?: yes

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): no

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

CODE NAME: STROBE TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Cavity, Beam Ducts, Flow Plate

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Beam Duct, Cavity Acoustics

ASSESSMENT OF CAPABILITIES: Multidimensional acoustics caused by non-ideal channels, i.e. beam ducts, standoff distance.

ASSESSMENT OF LIMITATIONS: Incomplete boundary condition formulation at open end, uses constant pressure which is not accurate.

OTHER UNIQUE FEATURES:

ORIGINATOR/KEY CONTACT:

Name: B. Masson

Organization: RDA

Address: ATO Box 9377, International Airport, Alb, NM 87119

Phone: (505) 243-5609

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T, L

STATUS:

Operational Currently?: yes

Under Modification?: yes

Purpose(s): Beam Duct Model being improved

Ownership?: RDA

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY I

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: None

SELF-CONTAINED?:

Other Codes Required (name, purpose): r Plotter

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS: Report in preparation.

GAS DYNAMICS CODE

CODE NAME: STROBE

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: ______ Expanding: √
   - FLUID GRID DIMENSIONALITY (√):
     - 1-D: ______
     - 2-D: ______
     - 3-D: √
     - Time Dependent: √
   - FLOW FIELD MODELED (√):
     - Compressible Flow: √
     - Incompressible: ______
     - Viscous Flow: ______
     - No Flow: ______
   - BASIC MODELING APPROACH (√):
     - Algebraic: ______ Integral Method: ______
     - Finite Difference: √
     - Others (specify): ______
   - REFERENCE FOR APPROACH USED: MacCormack

2. GAS DYNAMICS MODEL FEATURES:
   - GAS SUPPLY MODELED (√):
     - Mixture Preparation: ______
     - Mixture Injection: ______
       - Nozzles: ______
       - Flow Plates: √
       - Others (specify): ______
   - CAVITY INITIAL CONDITION DETERMINED BY (specify): Input

3. EXHAUST/RECIRCULATION MODEL
   - GENERAL SYSTEM MODELED (√):
     - Open System: √ Closed System: ______
     - Closed Cycle: ______
   - EXHAUST SYSTEM FEATURES (√):
     - Pressure Recovery: ______
     - Ejector System: ______
     - Compressor/Fan: ______
     - Heat Exchanger: ______
     - Gas Make-Up: ______
     - Others (specify): Absorbers

   - DECONTAMINATION METHOD TREATED (√):
     - Scrubber: ______
     - Shower: ______
     - Catalytic Reactor: ______
     - Others (specify): ______

4. ACOUSTIC ATTENUATION MODEL
   - GENERAL FEATURES MODELED (√):
     - Single Pulse: √ Repetitive Pulse: ______
   - DIMENSIONALITY TREATED (√):
     - 1-D: ______ 2-D: ______ 3-D: √
     - Time-Dependent: √
   - DISTURBANCE MODELED (√):
     - Pressure Wave: √ Entropy Wave: √
     - Others (specify): ______
   - WAVE PROPAGATION TREATMENT (√):
     - Linear Wave: ______
     - Nonlinear Wave: √
     - Others (specify): ______
   - THEORETICAL BASIS: (Reference) ______
   - NUMERICAL METHODOLOGY: (Reference) ______
   - ACOUSTIC ATTENUATORS CONSIDERED (√):
     - Muffler: √ Heat Exchanger: ______
     - Horn: ______ Porous Wall: ______
     - Others (specify): ______

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):
   - Index of Refraction Variation?: √
   - Other (specify): ______

OTHER UNIQUE FEATURES: ______

CODE NAME: SUPERSONIC TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Analysis of an electrically excited supersonic flow CO laser.

ASSESSMENT OF CAPABILITIES: Analysis of an electrically excited supersonic CO laser, with coupled molecular kinetics, plasma kinetics, gas dynamics, and optical extraction. (Simple one-dimensional models for gas dynamics and resonator.)

ASSESSMENT OF LIMITATIONS: Simplified treatment of gas dynamics and optical resonator.

OTHER UNIQUE FEATURES: Provides for multiple lasing transitions, and includes the effects of resonant self-absorption from overlapping transitions in a high pressure gas system. Plasma kinetics are provided by Boltzmann equation, completely coupled to molecular kinetics and optical extraction.

ORIGINATOR/KEY CONTACT:

Name: William B. Lacina

Organization: Northrop Research and Technology Center

Address: One Research Park, Palos Verdes Estates, CA 90274

Phone: (213) 377-4811 ext. 362

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

"Supersonic Continuous Wave Carbon Monoxide Laser Development, Phase I. Vol I: CO Laser Kinetics Code. Vol. IV: Rates and Cross Sections, "Northrop Rept. #NRTC-75-25R, July 1975. #NRTC-75-50R, NRTC-76-18R.
(T,U,L) Miscellaneous papers.

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s):

Ownership?: Northrop Research & Tech./ William B. Lacina

Proprietary?: No. Public Domain

MACHINE/OPERATING SYSTEM (on which installed): CDC 6600

TRANSPORTABLE?: yes

Machine Dependent Restrictions: yes

SELF-CONTAINED?: YES

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines:

COMMENTS:

KINETICS CODE

CODE NAME: SUPERSONIC

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ______ Expanding: ______

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ______

3-D: ______

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ______

Flow Direction: ______

KINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ______

Implicit: ______

Others (specify): ______

REFERENCE OF METHOD USED: ______

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ______

Number of Negative Species: ______

Number of Neutral Species: ______

REACTION MECHANISM MODELED (√):

Primary Ionization: (Reference)

E-Beam: ______

Self-Sustained: ______

UV-Initiated: ______

Others (specify): ______

Secondary Ionization (Reference)

Attachment: ______

Detachment: ______

Ion-Ion Recombination: ______

Charge Transfer: ______

Dissociation/Recombination: ______

Others (specify): ______

Source of Rate Coefficients Used: ______

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ______

E-Field: ✓

Others (specify): ______

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: $CO/N_2/\cdots X$

Number of Species: ~3

Number of Reactions: ______

Other Major Species Considered: ______

IMPACT EXCITATION MODELED (√):

(Reference)

Vibrational: ✓

Electronic: ______

Others (specify): ______

ENERGY TRANSFER MODES MODELED (√):

(Reference)

V-T: ✓

V-R: ______

V-V: ✓

Others (specify): ______

Lasing Transition: P-Branch: ✓

R-Branch: ______

Single Line Model (√): ______

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ______

Number of Laser Lines Modeled: ≲ 25

Source of Rate Coefficients Used in Code: Misc.

LINE PROFILE MODELS (√):

Doppler Broadening: ______

Collisional Broadening: ✓

Others (specify): ______

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ______ OH_x: ______

NO_x: ______ HNO_x: ______

Others (specify): ______

REFERENCE FOR REACTION MECHANISM AND RATES: ______

OTHER UNIQUE FEATURES: ______

AD-A132 352 A SURVEY OF ELECTRIC LASER CODES(U) LOCKHEED MISSILES AND SPACE CO INC HUNTSVILLE AL HUNTSVILLE R.. F C WANG JUN 83 LMSC-HREC-TR-D784124 DRSMI/RH-CR-83-6 2/2

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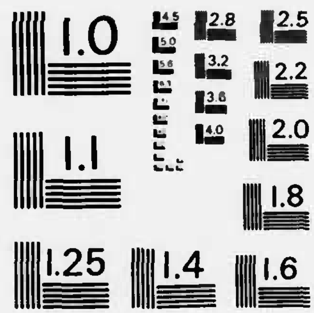

MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CODE NAME: TDFI-EDL TECHNICAL AREA(S): Optics, Kinetics, Gas Dynamics

DEVICE COMPONENTS TREATED: Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Estimate performance trends of CW EDL with unstable resonator.

ASSESSMENT OF CAPABILITIES: Two-Dimensional Fresnel integral (cylindrical optics) code coupled to detailed EDL plasma kinetics code including E-Beam and discharge model.

ASSESSMENT OF LIMITATIONS: Cavity analysis restricted to cylindrical mirror configurations.

OTHER UNIQUE FEATURES: Fully coupled kinetics and wave optics code.

ORIGINATOR/KEY CONTACT:

Name: Jurgen Thoenes

Organization: Lockheed-Huntsville Research & Engineering Center

Address: 4800 Bradford Dr., Huntsville, AL 35807

Phone: (205) 837-1800 ext. 416

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): J. Thoenes, S.C. Kurzius, M.L. Pearson "EDL Performance Model, Part I - Theory and User's Guide", U.S. Army Missile Command, TR RG-CR-75-2, June 1975. (T & U)

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s): Requires updating; not used for several years.

Ownership?: Lockheed-Huntsville

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which Installed):

TRANSPORTABLE?: yes

Machine Dependent Restrictions: CDC 6600/7600

SELF-CONTAINED?:

Other Codes Required (name, purpose): [illegible] :tron Kinetics Code

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	210	100
Large Job:		

Approximate Number of FORTRAN Lines: 5100

COMMENTS:

KINETICS CODE

CODE NAME: EDL (TDFI-EDL)

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ✓

KINETICS MODELED: Pulsed: ____ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ✓ (flow field)

Implicit: ✓ (kinetics)

Others (specify): ____

REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: Input

Number of Negative Species: Input

Number of Neutral Species: Input

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	same
Self-Sustained:		
UV-Initiated:		

Others (specify): ____

Secondary Ionization		(Reference)
Attachment:	✓	same
Detachment:	✓	
Ion-Ion Recombination:	✓	
Charge Transfer:	✓	
Dissociation/ Recombination:	✓	

Others (specify): ____

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ✓

Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: CO_2

Number of Species: Input

Number of Reactions: Input

Other Major Species Considered: N_2, He, H_2, O_2

IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:	✓	same
Electronic:	✓	
Others (specify):	Ionization	

ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	same
V-R:		
V-V:	✓	

Others (specify): ____

Lasing Transition: P-Branch: ✓

R-Branch: ____

Single Line Model (√): ✓

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ____

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: same

LINE PROFILE MODELS (√):

Doppler Broadening: ✓

Collisional Broadening: ✓

Others (specify): Voigt Function

4. RECIRCULATION CONTAMINANTS MODELED (√):

O_x: ✓ OH_x: ✓

NO_x: ✓ HNO_x: ✓

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: same

OTHER UNIQUE FEATURES: ____

GAS DYNAMICS CODE

CODE NAME: EDL (TDFI-EDL)

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: ✓ Expanding: ____
   - FLUID GRID DIMENSIONALITY (√):
     - 1-D: ✓
     - 2-D: ____
     - 3-D: ____
     - Time Dependent: ____
   - FLOW FIELD MODELED (√):
     - Compressible Flow: ✓
     - Incompressible: ____
     - Viscous Flow: ____
     - No Flow: ____
   - BASIC MODELING APPROACH (√):
     - Algebraic: ____ Integral Method: ____
     - Finite Difference: ✓
     - Others (specify): ____

   REFERENCE FOR APPROACH USED: Euler integration

2. GAS DYNAMICS MODEL FEATURES:
   - GAS SUPPLY MODELED (√):
     - Mixture Preparation: ____
     - Mixture Injection: ____
       - Nozzles: ____
       - Flow Plates: ____
       - Others (specify): ____

   CAVITY INITIAL CONDITION DETERMINED BY (specify): Specified (input)

3. EXHAUST/RECIRCULATION MODEL
   - GENERAL SYSTEM MODELED (√):
     - Open System: ✓ Closed System: ____
     - Closed Cycle: ✓
   - EXHAUST SYSTEM FEATURES (√):
     - Pressure Recovery: ____
     - Ejector System: ____
     - Compressor/Fan: ____
     - Heat Exchanger: ____
     - Gas Make-Up: ____
     - Others (specify): Circulator analysis ~~requires specification of temp. and flow velocity as function of time around loop.~~

DECONTAMINATION METHOD TREATED (√):
- Scrubber: ✓
- Shower: ____
- Catalytic Reactor: ✓
- Others (specify): Modeled by adjusting mix composition

4. ACOUSTIC ATTENUATION MODEL
   - GENERAL FEATURES MODELED (√):
     - Single Pulse: ____ Repetitive Pulse: ____
   - DIMENSIONALITY TREATED (√):
     - 1-D: ____ 2-D: ____ 3-D: ____
     - Time-Dependent: ____
   - DISTURBANCE MODELED (√):
     - Pressure Wave: ____ Entropy Wave: ____
     - Others (specify): ____
   - WAVE PROPAGATION TREATMENT (√):
     - Linear Wave: ____
     - Nonlinear Wave: ____
     - Others (specify): ____
   - THEORETICAL BASIS: (Reference) ____
   - NUMERICAL METHODOLOGY: (Reference) ____
   - ACOUSTIC ATTENUATORS CONSIDERED (√):
     - Muffler: ____ Heat Exchanger: ____
     - Horn: ____ Porous Wall: ____
     - Others (specify): ____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):
   - Index of Refraction Variation?: ____
   - Other (specify): Random noise

   OTHER UNIQUE FEATURES: ____

OPTICS CODE

CODE NAME: FICP (TDFI-EDL)

1. CODE STRUCTURE

BASIC TYPE (✓):

- Physical Optics: FRESNEL INTEGRAL
- Geometrical: ____
  - Constant Gain: ____ Floating Gain: ____

FIELD (POLARIZATION) REPRESENTATION (✓):

- Scalar: ____
- Vector: ✓

COORDINATE SYSTEM (✓):

- Cartesian: ✓
- Expanding (specify): ____

TRANSVERSE GRID DIMENSIONALITY (specify):

- One-Dimensinnal: ✓
- Two-Dimensional: ____

FIELD SYMMETRY RESTRICTIONS?: ____

MIRROR SHAPE(S) ALLOWED (✓):

- Square: ✓
- Rectangular: ✓
- Circular: ____
- Elliptical: ____
- Strip: ✓
- Arbitrary: ____

CONFIGURATION FLEXIBILITY (✓):

- Fixed, Single Resonator Geometry: ✓
- Fixed, Multiple Resonator Geometries: ____
- Modular, Multiple Resonator Geometries: ____
- Others (describe): ____

2. PROPAGATION TECHNIQUE (✓ all that apply):

- Fresnel Integral Algorithms: ✓
  - With Kernel Averaging: ____
  - Gaussian Quadrature: ____
  - Fast Fourier Transform (FFT): ____
  - Fast Hankel Transform (FHT): ____
  - Gardener-Fresnel-Kirchhoff (GFK): ____
  - Others (specify): ____
- Finite Difference Algorithms
  - Method (specify): ____

CONVERGENCE (✓):

- Technique:
  - Power Comparison: ✓
  - Field Comparison: ✓
  - Others (specify): ____
- Acceleration Algorithms Used?: ____
  - Technique: ____

MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS (✓):

- Prony: ____
- Others (specify): ____

3. RESONATOR MODELING FEATURES

GENERAL CAPABILITIES:

- Stability (✓):
  - Stable Resonators: ✓
  - Unstable Resonatnrs: ✓
- Type (✓)
  - Standing Wave: ✓
  - Traveling Wave (Ring): ____
  - Reverse Traveling Wave: ____
- Branch (✓):
  - Positive: ____
  - Negative: ____
- Optical Element Models Included (✓):
  - Flat Mirrors: ____
  - Spherical Mirrors: ____
  - Cylindrical Mirrors: ✓
  - Telescopes: ____
  - Scraper Mirrors: ✓
  - Deformable Mirrors: ____
  - Spatial Filters: ____
  - Gratings (specify type): ____
  - Other Elements (specify): Focusing output mirror

PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List):

Unstable resonator with focused oblique output beam.

(Continued)

OPTICS CODE
(Concluded)

CODE NAME

GAIN MODELS (✓):

- Bare Cavity Only: ✓
- Simple Saturated Gain: ✓
- Detailed Model (See Section 3 in Kinetics Code) ✓

BARE CAVITY FIELD MODIFIER MODELS (✓):

- Mirror Tilt: ✓
- Mirror Decentration: ____
- Aberrations/Thermal Distortion:
  - Arbitrary: ____
  - Selected (specify): ____
- Reflectivity Loss: ✓
- Output Coupler Edges
  - Rolled: ____
  - Serrated: ____
  - Other: ____

LOADED CAVITY FIELD MODIFIER MODELS (✓):

- Refractive Index Variation: ____
- Gas Absorption: ____
- Overlapped Beams (for flux updating): ____
  - Number of Overlaps Allowed: ____
- Others: Random noise option and starter

4. FAR FIELD MODELS (✓):

- Beam Steering Removal: ____
- Optimal Focal Search: ____
- Beam Quality: ____
- Atmospheric Propagation Effects: ____
- Others: Non-Amplified oblique focused output beam.

BEAM CONTROL SYSTEM MODELED (✓):

- Pointer/Tracker Subsystem: ____
- Beam Jitter: ____
- Autoalignment: ____
- Target Model:
  Motion: ____ Effects: ____

OTHER UNIQUE FEATURES (e.g., Beam/Mode Rotation, Extra-Cavity Adaptive Optics, Multipath/Parasitic Effect, Beam Director Elements, etc.):

____

CODE NAME: TEA Laser Kinetics Program TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the laser kinetics of a pulsed 10.6 μm CO_2 laser and to predict the performance of the laser.

ASSESSMENT OF CAPABILITIES: Can handle gas mixtures of CO_2: N_2: He: H_2O: H_2 at any temperature and pressure, and pulse lengths from one to twenty microseconds

ASSESSMENT OF LIMITATIONS: Is one-dimensional, can only model stable resonators, cannot handle very short pulses in which Boltzmann equilibrium for the vibrational modes is not a good approximation, and the rotational and kinetic temperatures are the same.

OTHER UNIQUE FEATURES: A six-temperature kinetic model is used which includes E/N-dependent electrical excitation and 29 temperature-dependent collisional relaxation rates.

ORIGINATOR/KEY CONTACT:

Name: Lyle Taylor

Organization: Westinghouse Electric Corporation

Address: 1310 Beulah Rd., Pittsburgh, PA 15668

Phone: 412-256-5833

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T: L.H. Taylor, L.A. Weaver, and R.W. Liebermann, "An Electric Discharge CO_2 Laser Kinetics Model. I. Theoretical Formulation, "Westinghouse Paper 78-1C2-ADLAS-P1 (1978). T: L.H. Taylor and L.A. Weaver, "An Electric Discharge CO_2 Laser Kinetics Model. II. Collisional Rates, "Westinghouse Paper 78-1C2-ADLAS-P2 (1978) U: L.H. Taylor, R.W. Liebermann, and L.A. Weaver, "User's Manual for the Westinghouse Transversely Excited Atmospheric (TEA) CO_2 Laser Kinetics Computer Program," Westinghouse Report 75-9C2-LASEX-R2 (1975).

STATUS:

Operational Currently?: Yes

Under Modification?: No

Purpose(s):

Ownership?: U. S. Government

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): U-1106 and CDC-7600

TRANSPORTABLE?: Yes

Machine Dependent Restrictions: FORTRAN IV

SELF-CONTAINED?: yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	14501	7 sec, CDC-7600
Large Job:		

Approximate Number of FORTRAN Lines: 736

COMMENTS:

Fabry-Perot Cavity modeled using geometric optics with floating gain.

KINETICS CODE

CODE NA[illegible] ________

1. CODE STRUCTURE
   COORDINATE SYSTEM (√):
   Cartesian: ✓ Expanding: ____
   KINETICS GRID DIMENSIONALITY (√):
   1-D: ✓ 2-D: ____
   3-D: ____
   GAIN REGION SYMMETRY RESTRICTIONS:
   Gain Vary Along Optical Axis: no
   Flow Direction: no
   KINETICS MODELED: Pulsed: ✓ CW: ✓
   NUMERICAL SCHEME USED IN RATE CALCULATION (√):
   Explicit: ____
   Implicit: ____
   Others (specify): Hamming

   REFERENCE OF METHOD USED: R. W. Hamming, Numerical Methods for Engineers and Scientists (1962).

2. PLASMA KINETICS MODEL
   NUMBER OF SPECIES TREATED (specify):
   Number of Positive Species: ____
   Number of Negative Species: ____
   Number of Neutral Species: ____
   REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:		
Self-Sustained:	✓	
UV-Initiated:	✓	

   Others (specify): ____

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:	✓	
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/Recombination:		

   Others (specify): ____
   Source of Rate Coefficients Used: ____

   DISCHARGE POWER INPUT MODELED (√):
   Uniform: ✓ Non-Uniform: ____
   E-Field: ____
   Others (specify): ____

3. LASING KINETICS MODEL
   GENERAL (specify):
   Lasing Species: CO_2
   Number of Species: 5
   Number of Reactions: 29
   Other Major Species Considered: He, N_2, H_2O, H_2

   IMPACT EXCITATION MODELED (√):

		(Reference)
Vibrational:		
Electronic:		
Others (specify):		

   ENERGY TRANSFER MODES MODELED (√):

		(Reference)
V-T:	✓	
V-R:		
V-V:	✓	

   Others (specify): ____
   Lasing Transition: P-Branch: ✓
   R-Branch: ✓
   Single Line Model (√): ✓
   Multi-Line Model (√): ✓
   Assumed Rotational Population Distribution State (√):
   Equilibrium: ✓
   Nonequilibrium: ____
   Number of Laser Lines Modeled: Several
   Source of Rate Coefficients Used in Code: Westinghouse Paper 78-1C2-ADLAS-P2 (1978)

   LINE PROFILE MODELS (√):
   Doppler Broadening: ✓
   Collisional Broadening: ✓
   Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none
   N: ____ OH_x: ____
   NO_x: ____ HNO_x: ____
   Others (specify): ____

   REFERENCE FOR REACTION MECHANISM AND RATES: ____

   OTHER UNIQUE FEATURES: ____

CODE NAME: TELSAT TECHNICAL AREA(S): Gas Dynamics

DEVICE COMPONENTS TREATED: Overall System Characteristics

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Study steady state and transient Thermodynamic and Fluid Dynamic System Performance.

ASSESSMEN. OF CAPABILITIES: 1-D time dependent assessment of thermodynamic and fluid dynamic performance of laser components and their interactions within the laser system.

ASSESSMENT OF LIMITATIONS: limited to 1-D problems.

OTHER UNIQUE FEATURES: Developed in "building block" format and easily adaptable to different systems (i.e. closed or open loop) can also be used to model non-EDL systems.

ORIGINATOR/KEY CONTACT:

Name: Earl White

Organization: R&D Associates

Address: ATO 9377 International Airport Albuquerque, NM 87119

Phone: (505) 844-8446

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): T, L, RP

STATUS:

Operational Currently?: yes

Under Modification?:

Purpose(s):

Ownership?: R&D Associates

Proprietary?: No

MACHINE/OPERATING SYSTEM (on which installed): CRAY-1

TRANSPORTABLE?: yes

Machine Dependent Restrictions: none

SELF-CONTAINED?:

Other Codes Required (name, purpose): none

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	68096 (Version 1)	44 sec
Large Job:	118272 (Version 2)	154 sec

Approximate Number of FORTRAN Lines:

COMMENTS:

GAS DYNAMICS CODE

CODE NAME: TELSAT

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: ✓ Expanding: ______
   - FLUID GRID DIMENSIONALITY (√):
     - 1-D: ✓
     - 2-D: ______
     - 3-D: ______
     - Time Dependent: ✓
   - FLOW FIELD MODELED (√):
     - Compressible Flow: ✓
     - Incompressible: ✓
     - Viscous Flow: ______
     - No Flow: ______
   - BASIC MODELING APPROACH (√):
     - Algebraic: ______ Integral Method: ______
     - Finite Difference: ✓
     - Others (specify): ______
   - REFERENCE FOR APPROACH USED: Blackburn-Fluid Power Control

2. GAS DYNAMICS MODEL FEATURES:
   - GAS SUPPLY MODELED (√):
     - Mixture Preparation: ✓
     - Mixture Injection: ______
       - Nozzles: ______
       - Flow Plates: ______
       - Others (specify): ______
   - CAVITY INITIAL CONDITION DETERMINED BY (specify): Input

3. EXHAUST/RECIRCULATION MODEL
   - GENERAL SYSTEM MODELED (√):
     - Open System: ______ Closed System: ______
     - Closed Cycle: ✓
   - EXHAUST SYSTEM FEATURES (√):
     - Pressure Recovery: ✓
     - Ejector System: ______
     - Compressor/Fan: ✓
     - Heat Exchanger: ✓
     - Gas Make-Up: ✓
     - Others (specify): Nozzles, ducting turbine

DECONTAMINATION METHOD TREATED (√):
- Scrubber: ______
- Shower: ______
- Catalytic Reactor: ______
- Others (specify): ______

4. ACOUSTIC ATTENUATION MODEL
   - GENERAL FEATURES MODELED (√):
     - Single Pulse: ______ Repetitive Pulse: ______
   - DIMENSIONALITY TREATED (√):
     - 1-D: ______ 2-D: ______ 3-D: ______
     - Time-Dependent: ______
   - DISTURBANCE MODELED (√):
     - Pressure Wave: ______ Entropy Wave: ______
     - Others (specify): ______
   - WAVE PROPAGATION TREATMENT (√):
     - Linear Wave: ______
     - Nonlinear Wave: ______
     - Others (specify): ______
   - THEORETICAL BASIS: (Reference) ______
   - NUMERICAL METHODOLOGY: (Reference) ______
   - ACOUSTIC ATTENUATORS CONSIDERED (√):
     - Muffler: ______ Heat Exchanger: ______
     - Horn: ______ Porous Wall: ______
     - Others (specify): ______

5. MODEL EFFECTS ON OPTICAL MODES DUE TO:
   - Index of Refraction Variation?: ______
   - Other (specify): ______

OTHER UNIQUE FEATURES: ______

CODE NAME: UNSEDL2 TECHNICAL AREA(S): Optics/Kinetics/Gas Dynamics

DEVICE COMPONENTS TREATED: CO_2 EDL

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Time dependent behavior of CW CO_2 EDL with mode media instability.

ASSESSMENT OF CAPABILITIES: 2-D flow + kinetics; FFT optics

ASSESSMENT OF LIMITATIONS: Very expensive to run

OTHER UNIQUE FEATURES: Dynamic Dimensioning

ORIGINATOR/KEY CONTACT:

Name: Ted Salvi

Organization: AFWL/ARAO

Address: Kirtland AFB, NM 87117

Phone: 505-844-0256

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

U,L

T: Jumper, G.Y., Hines, J.D., and Salvi, T.C. & Riker, J.F., "The Dependent Numerical Prediction of CO_2 Electric Discharge Laser Performance".

STATUS:

Operational Currently?: yes

Under Modification?: no

Purpose(s): Not currently being used

Ownership?: USAF

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CDC 7600 (Cyber 176)

TRANSPORTABLE?: no

Machine Dependent Restrictions: IO; Assembly language FFT

SELF-CONTAINED?:

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:		
Large Job:		

Approximate Number of FORTRAN Lines: 10,000

COMMENTS:

KINETICS CODE

CODE NAME: UNSEDL2

1. CODE STRUCTURE
   - COORDINATE SYSTEM (√):
     - Cartesian: √ Expanding: ____
   - KINETICS GRID DIMENSIONALITY (√):
     - 1-D: ____ 2-D: √
     - 3-D: ____
   - GAIN REGION SYMMETRY RESTRICTIONS:
     - Gain Vary Along Optical Axis: Multiple sheet
     - Flow Direction: √
   - KINETICS MODELED: Pulsed: √ CW: √ (Time Dep)
   - NUMERICAL SCHEME USED IN RATE CALCULATION (√):
     - Explicit: √
     - Implicit: ____
     - Others (specify): ____
   - REFERENCE OF METHOD USED: MacCormack's Fluid Dyanmic, extended to kinetics

2. PLASMA KINETICS MODEL Energy levels:
   - NUMBER OF SPECIES TREATED (specify): E Upper, E lower, E N_2
     - Number of Positive Species: ____
     - Number of Negative Species: ____
     - Number of Neutral Species: ____
   - REACTION MECHANISM MODELED (√):
     - Primary Ionization: (Reference)
       - E-Beam: √
       - Self-Sustained: ____
       - UV-Initiated: ____
       - Others (specify): ____
     - Secondary Ionization (Reference)
       - Attachment: ____
       - Detachment: ____
       - Ion-Ion Recombination: ____
       - Charge Transfer: ____
       - Dissociation/Recombination: √
       - Others (specify): ____
       - Source of Rate Coefficients Used: ____
   - DISCHARGE POWER INPUT MODELED (√):
     - Uniform: ____ Non-Uniform: √
     - E-Field: ____
     - Others (specify): ____

3. LASING KINETICS MODEL
   - GENERAL (specify):
     - Lasing Species: CO_2 (001)
     - Number of Species: 3
     - Number of Reactions: 6
     - Other Major Species Considered: ____
   - IMPACT EXCITATION MODELED (√): (Reference)
     - Vibrational: √
     - Electronic: ____
     - Others (specify): ____
   - ENERGY TRANSFER MODES MODELED (√): (Reference)
     - V-T: √
     - V-R: √
     - V-V: √
     - Others (specify): ____
     - Lasing Transition: P-Branch: √
     - R-Branch: √
     - Single Line Model (√): ____
     - Multi-Line Model (√): ____
       - Assumed Rotational Population Distribution State (√):
         - Equilibrium: √
         - Nonequilibrium: ____
       - Number of Laser Lines Modeled: 2 (10.6 - 9.28)
     - Source of Rate Coefficients Used in Code: Various
   - LINE PROFILE MODELS (√):
     - Doppler Broadening: ____
     - Collisional Broadening: √
     - Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): None
   - O_x: ____ OH_x: ____
   - NO_x: ____ HNO_x: ____
   - Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: various

OTHER UNIQUE FEATURES: ____

GAS DYNAMICS CODE

CODE NAME: UNSEDL2

1. CODE STRUCTURE
   COORDINATE SYSTEM (√):
   Cartesian: ✓ Expanding: ____
   FLUID GRID DIMENSIONALITY (√):
   1-D: ____
   2-D: ✓
   3-D: ____
   Time Dependent: ✓
   FLOW FIELD MODELED (√):
   Compressible Flow: ✓
   Incompressible: ____
   Viscous Flow: ____
   No Flow: ____
   BASIC MODELING APPROACH (√):
   Algebraic: ____ Integral Method: ____
   Finite Difference: ✓
   Others (specify): actually finite element
   REFERENCE FOR APPROACH USED: MacCormack

2. GAS DYNAMICS MODEL FEATURES:
   GAS SUPPLY MODELED (√):
   Mixture Preparation: ____
   Mixture Injection: ____
   Nozzles: Variable Geometry
   Flow Plates: Choked or face plate
   Others (specify): ____
   CAVITY INITIAL CONDITION DETERMINED BY (specify): solution of time dependent equations, no energy input.

3. EXHAUST/RECIRCULATION MODEL
   GENERAL SYSTEM MODELED (√):
   Open System: ✓ Closed System: ____
   Closed Cycle: ____
   EXHAUST SYSTEM FEATURES (√):
   Pressure Recovery: ✓
   Ejector System: ____
   Compressor/Fan: ____
   Heat Exchanger: ____
   Gas Make-Up: ____
   Others (specify): A recovery pressure is specified.

DECONTAMINATION METHOD TREATED (√):
   Scrubber: ____
   Shower: ____
   Catalytic Reactor: ____
   Others (specify): ____

4. ACOUSTIC ATTENUATION MODEL
   GENERAL FEATURES MODELED (√):
   Single Pulse: ____ Repetitive Pulse: ____
   DIMENSIONALITY TREATED (√):
   1-D: ____ 2-D: ____ 3-D: ____
   Time-Dependent: ____
   DISTURBANCE MODELED (√):
   Pressure Wave: ____ Entropy Wave: ____
   Others (specify): disturbance propagated by "hydro code" time dependent equations.
   WAVE PROPAGATION TREATMENT (√):
   Linear Wave: ____
   Nonlinear Wave: ____
   Others (specify): ____
   THEORETICAL BASIS: (Reference) ____
   NUMERICAL METHODOLOGY: (Reference) ____
   ACOUSTIC ATTENUATORS CONSIDERED (√): no
   Muffler: ____ Heat Exchanger: ____
   Horn: ____ Porous Wall: ____
   Others (specify): ____

5. MODEL EFFECTS ON OPTICAL MODES DUE TO (√):
   Index of Refraction Variation?: ✓
   Other (specify): gain variation

OTHER UNIQUE FEATURES: ____

OPTICS CODE

CODE NAME: UNSEDL2

1. CODE STRUCTURE

BASIC TYPE (√):

- Physical Optics: ✓
- Geometrical: ______
  - Constant Gain: ______ Floating Gain: ✓

FIELD (POLARIZATION) REPRESENTATION (√):

- Scalar: ✓
- Vector: ______

COORDINATE SYSTEM (√):

- Cartesian: ✓
- Expanding (specify): ✓

TRANSVERSE GRID DIMENSIONALITY (specify):

- One-Dimensional: ______
- Two-Dimensional: ✓ Dynamic

FIELD SYMMETRY RESTRICTIONS?: no

MIRROR SHAPE(S) ALLOWED (√):

- Square: ✓
- Rectangular: ✓
- Circular: ✓
- Elliptical: ______
- Strip: ✓
- Arbitrary: ______

CONFIGURATION FLEXIBILITY (√):

- Fixed, Single Resonator Geometry: ______
- Fixed, Multiple Resonator Geometries: ______
- Modular, Multiple Resonator Geometries: ✓
- Others (describe): ______

2. PROPAGATION TECHNIQUE (√ all that apply):

- Fresnel Integral Algorithms: ______
  - With Kernel Averaging: ✓
  - Gaussian Quadrature: ______
  - Fast Fourier Transform (FFT): ✓
  - Fast Hankel Transform (FHT): ______
  - Gardener-Fresnel-Kirchhoff (GFK): ______
  - Others (specify): ______
- Finite Difference Algorithms
  - Method (specify): ______

CONVERGENCE (√):

- Technique:
  - Power Comparison: ______
  - Field Comparison: ✓
  - Others (specify): ______
- Acceleration Algorithms Used?: No
  - Technique: ______

MULTIPLE EIGENVALUE/EIGENVECTOR EXTRACTOR ALGORITHMS (√):

- Prony: ______
- Others (specify): ______

3. RESONATOR MODELING FEATURES

GENERAL CAPABILITIES:

- Stability (√):
  - Stable Resonators: ______
  - Unstable Resonators: ✓
- Type (√)
  - Standing Wave: ✓
  - Traveling Wave (Ring): ______
  - Reverse Traveling Wave: ______
- Branch (√):
  - Positive: ✓
  - Negative: ______
- Optical Element Models Included (√):
  - Flat Mirrors: ✓
  - Spherical Mirrors: ✓
  - Cylindrical Mirrors: ______
  - Telescopes: ______
  - Scraper Mirrors: ✓
  - Deformable Mirrors: ______
  - Spatial Filters: ______
  - Gratings (specify type): ______
  - Other Elements (specify): ______

PRINCIPAL RESONATOR GEOMETRIES MODELED (Please List):

Sets up confocal automatically; other resonators can be set up with some additional minor difficulty.

(Continued)

OPTICS CODE
(Concluded)

CODE NAME: UNSEDL2

GAIN MODELS (✓):
- Bare Cavity Only: ______
- Simple Saturated Gain: ______
- Detailed Model (See Section 3 in Kinetics Code) ✓

BARE CAVITY FIELD MODIFIER MODELS (✓):
- Mirror Tilt: ______
- Mirror Decentration: ______
- Aberrations/Thermal Distortion:
  - Arbitrary: ______
  - Selected (specify): ✓
- Reflectivity Loss: ✓
- Output Coupler Edges
  - Rolled: ______
  - Serrated: ______
  - Other: ______

LOADED CAVITY FIELD MODIFIER MODELS (✓):
- Refractive Index Variation: ✓
- Gas Absorption: ✓
- Overlapped Beams (for flux updating): ✓
  - Number of Overlaps Allowed: can be easily set up
- Others: ______

FAR FIELD MODELS (✓):
- Beam Steering Removal: ______
- Optimal Focal Search: ______
- Beam Quality: ✓
- Atmospheric Propagation Effects: ______
- Others: ______

BEAM CONTROL SYSTEM MODELED (✓):
- Pointer/Tracker Subsystem: ______
- Beam Jitter: ______
- Autoalignment: ______
- Target Model:
  Motion: ______ Effects: ______

OTHER UNIQUE FEATURES (e.g., Beam/Mode Rotation, Extra-Cavity Adaptive Optics, Multipath/Parasitic Effect, Beam Director Elements, etc.):

______

CODE NAME: UVLZR TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Discharge, PFN

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Study kinetics of rare gas halide lasers, design more efficient PFN's.

ASSESSMENT OF CAPABILITIES: Code does quite well at describing the electrical characteristics (voltage, current, impedance) of RgH-discharge systems. In general code also predicts lasing onset well.

ASSESSMENT OF LIMITATIONS: Code assume uniform gain and flux and this is bad. Therefore it does not accurately predict output energy. Code requires separate electro-kinetics code.

OTHER UNIQUE FEATURES: One version of the code has been modified to provide a gas-phase resistance in code SUPER SCEPTRE. This then permits modelling of nearly any PFN.

ORIGINATOR/KEY CONTACT:

Name: Arthur E. Greene

Organization: T-12, LASL

Address: MS.-569, Los Alamos Scientific Laboratory, Los Alamos, NM 87545

Phone: 505-667-7799

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

RP: A.E. Greene & C.A. Brau, IEEE J.Q.E. 14, 951, 1978

RP: A. E. Greene , C.R. Tallman, W.L. Willis, & C.A. Brau, Proceedings of International Conference on Lasers 1979, 211.

STATUS:

Operational Currently?: X

Under Modification?: X

Purpose(s): Work underway on moving from KrF to XeCl

Ownership?: LASL is funded by DOE

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CDC-7600/LTSS

TRANSPORTABLE?: yes

Machine Dependent Restrictions:

SELF-CONTAINED?: no

Other Codes Required (name, purpose): NOMAD - solves Boltzmann equation to find electron impact pumping rates.

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	637	12 sec
Large Job:		

Approximate Number of FORTRAN Lines: 600

COMMENTS:

KINETICS CODE

CODE NAME: UVLZR

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ____

KINETICS MODELED: Pulsed: ✓ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: ____

Implicit: ✓

Others (specify): ____

REFERENCE OF METHOD USED: Gear

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: 2

Number of Negative Species: 2

Number of Neutral Species: 4

REACTION MECHANISM MODELED (√):

Primary Ionization: (Reference)

E-Beam: ____

Self-Sustained: ____

UV-Initiated: ____

Others (specify): Electron impact avalanche

Secondary Ionization (Reference)

Attachment: ✓

Detachment: ✓

Ion-Ion Recombination: ✓

Charge Transfer: ____

Dissociation/Recombination: ✓

Others (specify): ____

Source of Rate Coefficients Used: see RP on page 1

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ✓

Others (specify): time varying

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: KrF* or RgH*

Number of Species: 1

Number of Reactions: 1

Other Major Species Considered: diluent Ne or He (or both), F_2 or halogen doner

IMPACT EXCITATION MODELED (√):

(Reference)

Vibrational: ____

Electronic: ✓

Others (specify): ____

ENERGY TRANSFER MODES MODELED (√):

(Reference)

V-T: ____

V-R: ____

V-V: ____

Others (specify): $Rg^+ + H^- \rightarrow RgH^*$

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (√): ✓

Multi-Line Model (√): ____

Assumed Rotational Population Distribution State (√):

Equilibrium: ____

Nonequilibrium: ____

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: see RP page #1

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (√): none

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: Numerous self absorption terms included.

CODE NAME: VIBKIN TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED: Laser Cavity

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: To model the kinetics of the vibration levels of carbon monoxide mixed with helium and argon cooled by supersonic expansion pumped by an electric discharge and unpumped by lasing.

ASSESSMENT OF CAPABILITIES: The model predicts the time histories of the lasing lines which are in very good agreement with pulsed and cw experiments in both small and large scale devices.

ASSESSMENT OF LIMITATIONS: About $50 cost per case to run.

OTHER UNIQUE FEATURES: Electron energy distribution from Boltzmann Eq. changes as vibration manifold changes. Includes vibration excitations by electron impact from excited levels. Modified Rigrod theory for laser cavity. Temperature dependent VV and VT rates and optical boradening cross sections. One dimensional flow eqns. with heat addition. Rotational thermal equilibrium. Includes CO R-branch resonance effects.

ORIGINATOR/KEY CONTACT:

Name: Donald John Nelson, MS 88-46

Organization: The Boeing Aerospace Company

Address: P.O. Box 3999 Seattle, WA 98124

Phone: (206) 773-1498

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication): The report: AFWL-TR-75-256 Supersonic CO Laser Code (SCOL Code), D.J. Pistores: and D.J. Nelson describes the theory and the comparison of some results with experiments. The report: AFWL-TR-76-5 Supersonic CO Laser Code, Operations Manual, E.G. Cate, D.J. Nelson and D.J. Pistores: describes the usage of the code and contains a source listing.

STATUS:

Operational Currently?: yes

Under Modification?: only slowly

Purpose(s): to continue improving the performance

Ownership?: AFWL and Boeing

Proprietary?:

MACHINE/OPERATING SYSTEM (on which installed): IBM 360/370/3032 at Boeing, CDC 6600 at AFWL

TRANSPORTABLE?: yes

Machine Dependent Restrictions: A few statements were changed when transferring between IBM and CDC machines.

SELF-CONTAINED?: yes

Other Codes Required (name, purpose):

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		G 50 CPUSEC for 30 μsec pulse
Typical Job:	C100K, L200K, G160K	C 20 CPUSEC G 90 CPUSEC for 60 μsec pulse
Large Job:		G 330 CPUSEC for 250 μsec pulse

Approximate Number of FORTRAN Lines: 2200

COMMENTS:

KINETICS CODE

CODE NAME: VIBKIN

1. CODE STRUCTURE

COORDINATE SYSTEM (√):

Cartesian: ✓ Expanding: ____

KINETICS GRID DIMENSIONALITY (√):

1-D: ✓ 2-D: ____

3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

Gain Vary Along Optical Axis: ____

Flow Direction: ✓

KINETICS MODELED: Pulsed: ✓ CW: ✓

NUMERICAL SCHEME USED IN RATE CALCULATION (√):

Explicit: 5th order Runge-Kutta for vibration kinetics

Implicit: tridiagonal iteration for electron distribution

Others (specify): ____

REFERENCE OF METHOD USED: ____

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

Number of Positive Species: ____

Number of Negative Species: ____

Number of Neutral Species: ____

REACTION MECHANISM MODELED (√):

Primary Ionization:		(Reference)
E-Beam:	✓	determines electron density
Self-Sustained:	✓	determines pumping rates
UV-Initiated:		

Others (specify): ____

Secondary Ionization	(Reference)
Attachment:	
Detachment:	
Ion-Ion Recombination:	
Charge Transfer:	
Dissociation/ Recombination:	

Others (specify): ____

Source of Rate Coefficients Used: ____

DISCHARGE POWER INPUT MODELED (√):

Uniform: ✓ Non-Uniform: ____

E-Field: ____

Others (specify): Function of time

3. LASING KINETICS MODEL

GENERAL (specify):

Lasing Species: Carbon Monoxide

Number of Species: 3

Number of Reactions: ____

Other Major Species Considered: Helium and Argon

IMPACT EXCITATION MODELED (√):

		(Reference) *
Vibrational:	✓	7,23,30,32
Electronic:		
Others (specify):		

ENERGY TRANSFER MODES MODELED (√):

		(Reference) *
V-T:	✓	10
V-R:		
V-V:	✓	8,9,33

Others (specify): ____

Lasing Transition: P-Branch: ✓

R-Branch: resonances wi

Single Line Model (√): ✓

Multi-Line Model (√): ✓

Assumed Rotational Population Distribution State (√):

Equilibrium: ✓

Nonequilibrium: ____

Number of Laser Lines Modeled: 5-rotational lines on each of 30 vibrational levels.

Source of Rate Coefficients Used in Code: ____

LINE PROFILE MODELS (√):

Doppler Broadening: ____

Collisional Broadening: ____

Others (specify): Voigt

4. RECIRCULATION CONTAMINANTS MODELED (√): None

O_x: ____ OH_x: ____

NO_x: ____ HNO_x: ____

Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: ____

* See reference on AFWL-TR-75-256

CODE NAME: XENON TECHNICAL AREA(S): Kinetics

DEVICE COMPONENTS TREATED:

PRINCIPAL PURPOSE(S)/APPLICATION(S) OF CODE: Synthesis of E-Beam initiated A_r-X_e laser.

ASSESSMENT OF CAPABILITIES: Calculates saturated power density for an E-Beam initiated discharge pumped Ar-Xe laser using 10-20 rate equations

ASSESSMENT OF LIMITATIONS: Boltzman code needed to calculate rate constants.

OTHER UNIQUE FEATURES: Collision effect on excited states treated implicitly.

ORIGINATOR/KEY CONTACT:

Name: T. DeTemple

Organization: U. of Ill.

Address: 200 EERL, Urbana, ILL 61801

Phone: 217-333-3094

AVAILABLE DOCUMENTATION (Please specify, use T = Theory, U = User's Manual, L = Listing, and RP = Related Publication):

S.A. Lawton, J.B. Richards, L.A. Newman, L. Specht, and T.A. DeTemple, "The High Pressure Neutral Infrared Xenon Laser", J.A.P. Vol. 50, p. 3888-3898. June 1979. (RP)

S. Lawton and T.A. DeTemple, "Near Infrared Gas Lasers" AFAPL-TR-78-107 (RP)

STATUS:

Operational Currently?: no

Under Modification?:

Purpose(s):

Ownership?:

Proprietary?: no

MACHINE/OPERATING SYSTEM (on which installed): CYBER 175

TRANSPORTABLE?: Yes

Machine Dependent Restrictions:

SELF-CONTAINED?:

Other Codes Required (name, purpose): CALCOMP

ESTIMATE OF RESOURCES REQUIRED FOR RUNS:

	Core Size (Octal Words)	Execution Time (sec, CDC 7600)
Small Job:		
Typical Job:	X	
Large Job:		

Approximate Number of FORTRAN Lines: Few 1000

COMMENTS:

KINETICS CODE

CODE NAME: XENON

1. CODE STRUCTURE

COORDINATE SYSTEM (✓):

- Cartesian: ✓ Expanding: ____
- KINETICS GRID DIMENSIONALITY (✓):
- 1-D: ✓ 2-D: ____
- 3-D: ____

GAIN REGION SYMMETRY RESTRICTIONS:

- Gain Vary Along Optical Axis: ____
- Flow Direction: ____

KINETICS MODELED: Pulsed: ✓ CW: ____

NUMERICAL SCHEME USED IN RATE CALCULATION (✓):

- Explicit: ____
- Implicit: ✓
- Others (specify): ____

REFERENCE OF METHOD USED: Gear Method

2. PLASMA KINETICS MODEL

NUMBER OF SPECIES TREATED (specify):

- Number of Positive Species: 5
- Number of Negative Species: 1
- Number of Neutral Species: 4

REACTION MECHANISM MODELED (✓):

Primary Ionization:		(Reference)
E-Beam:	✓	
Self-Sustained:	✓	
UV-Initiated:		
Others (specify):		

Secondary Ionization		(Reference)
Attachment:	✓	
Detachment:		
Ion-Ion Recombination:		
Charge Transfer:		
Dissociation/Recombination:	✓	
Others (specify):		

Source of Rate Coefficients Used: various

DISCHARGE POWER INPUT MODELED (✓):

- Uniform: ✓ Non-Uniform: ____
- E-Field: ____
- Others (specify): ____

3. LASING KINETICS MODEL

GENERAL (specify):

- Lasing Species: Xe
- Number of Species: 2
- Number of Reactions: ~40
- Other Major Species Considered: Molecular Ions, R.C. Molecules

IMPACT EXCITATION MODELED (✓):

		(Reference)
Vibrational:		
Electronic:	✓	
Others (specify):	Excited State	

ENERGY TRANSFER MODES MODELED (✓):

		(Reference)
V-T:		
V-R:		
V-V:		
Others (specify):	Electronic	

Lasing Transition: P-Branch: ____

R-Branch: ____

Single Line Model (✓): ✓

Multi-Line Model (✓): ____

Assumed Rotational Population Distribution State (✓):

- Equilibrium: ____
- Nonequilibrium: ____

Number of Laser Lines Modeled: 1

Source of Rate Coefficients Used in Code: Various

LINE PROFILE MODELS (✓):

- Doppler Broadening: ____
- Collisional Broadening: ____
- Others (specify): ____

4. RECIRCULATION CONTAMINANTS MODELED (✓): none

- O_x: ____ OH_x: ____
- NO_x: ____ HNO_x: ____
- Others (specify): ____

REFERENCE FOR REACTION MECHANISM AND RATES: ____

OTHER UNIQUE FEATURES: Corrects for excited state dependence on electron distribution function.

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3. Epstin, M., and R. R. Giedt, "Pulsed Chemical Laser Code Survey," Aerospace Corporation TOR-0082 (2704)-1, December 1981.

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J. Thoenes, and S.C. Kurzius, "Plasma Chemistry Processes in the Closed Cycle EDL," Technical Report DRCPM-HEL-CR-79-11, Volume I, Lockheed Missiles & Space Company, Huntsville, Ala., July 1979.

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